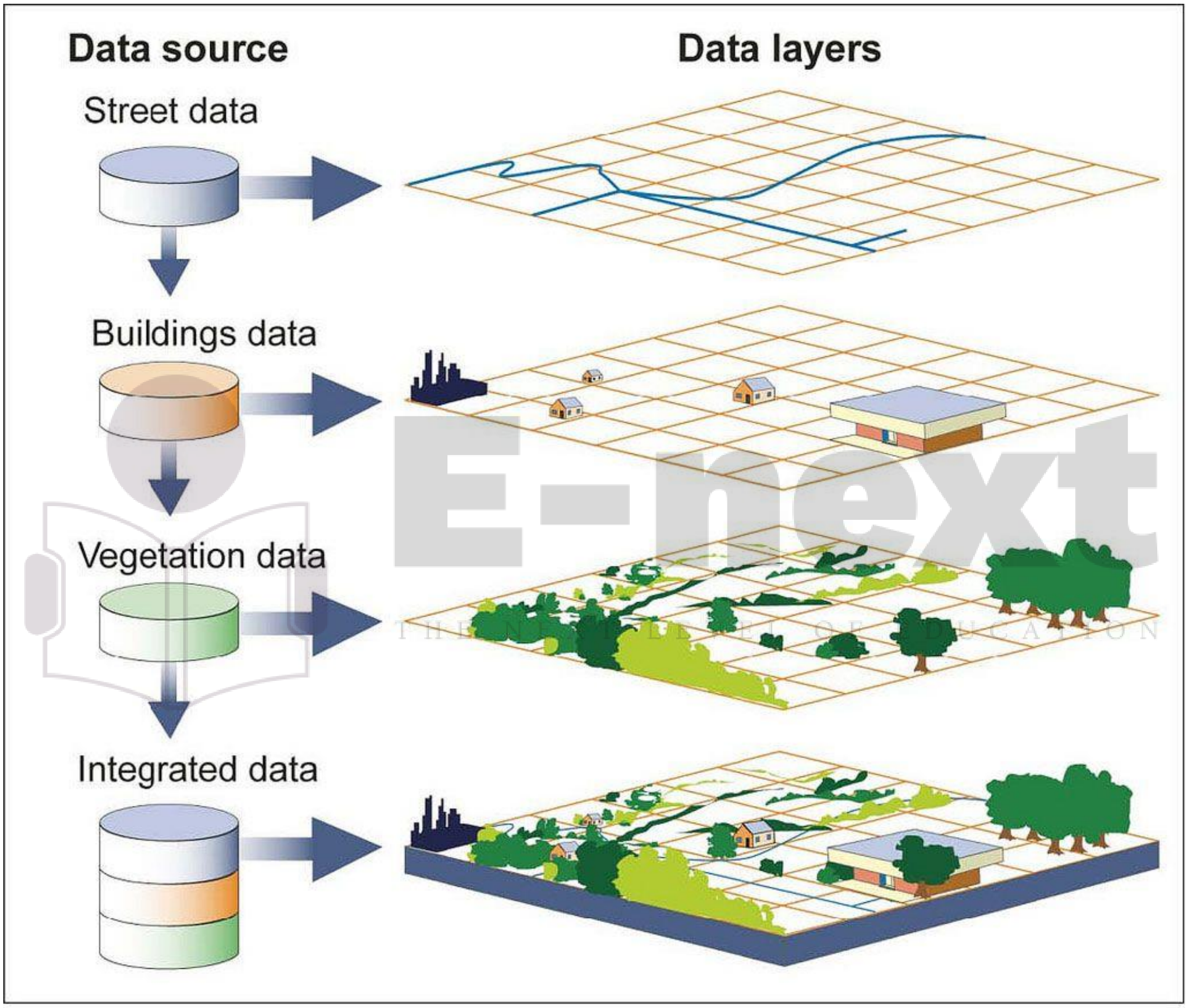
UNIT I

Spatial Data Concepts

Q-1) What is GIS? (2014)



Source: GAO.

A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth's surface. By relating seemingly unrelated data, GIS can help individuals and organizations better understand spatial patterns and relationships.

GIS technology is a crucial part of spatial data infrastructure, which the White House defines as "the technology, policies, standards, human resources, and related activities necessary to acquire, process, distribute, use, maintain, and preserve spatial data."

GIS can use any information that includes location. The location can be expressed in many different ways, such as latitude and longitude, address, or ZIP code.

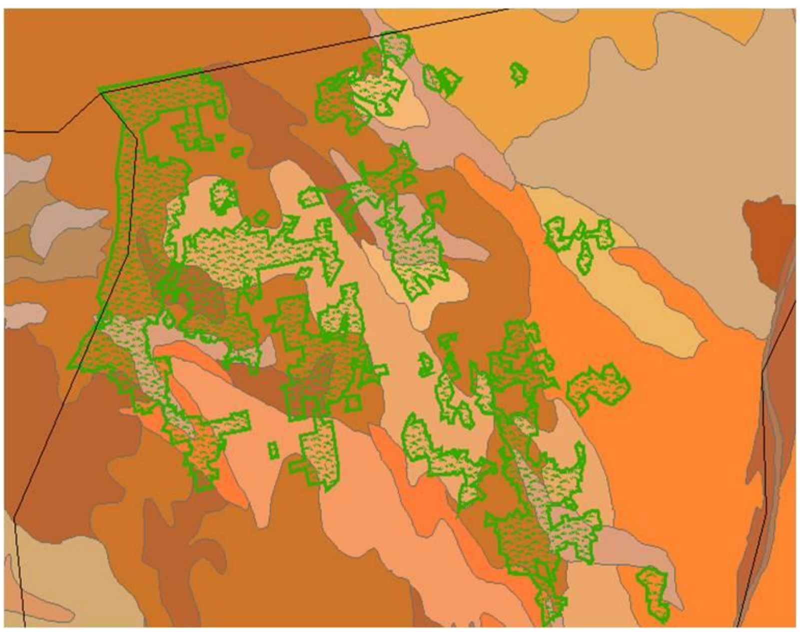
Many different types of information can be compared and contrasted using GIS. The system can include data about people, such as population, income, or education level. It can include information about the landscape, such as the location of streams, different kinds of vegetation, and different kinds of soil. It can include information about the sites of factories, farms, and schools; or storm drains, roads, and electric power lines.

With GIS technology, people can compare the locations of different things in order to discover how they relate to each other. For example, using GIS, a single map could include sites that produce pollution, such as factories, and sites that are sensitive to pollution, such as wetlands and rivers. Such a map would help people determine where water supplies are most at risk.

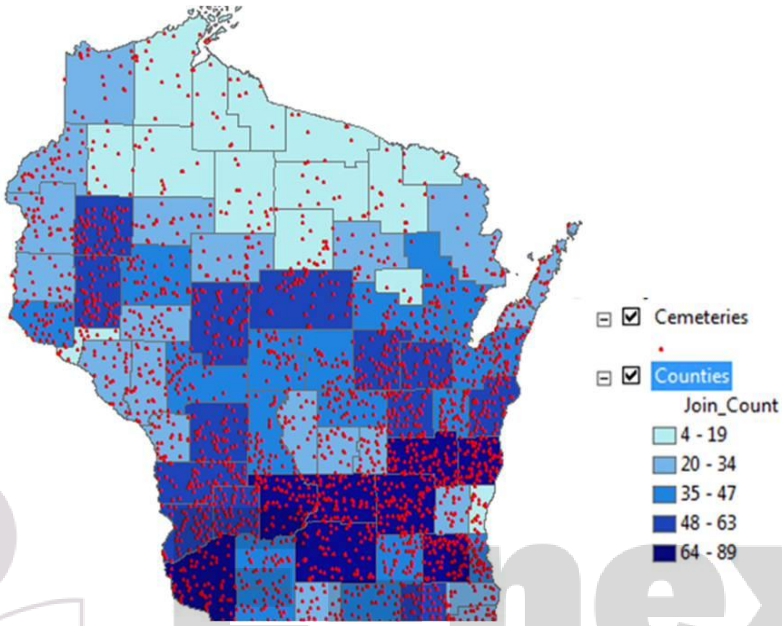
Q-2) What can we do with GIS?

GIS can be used as tool in both problem solving and decision making processes, as well as for visualization of data in a spatial environment. Geospatial data can be analyzed to determine (1) the location of features and relationships to other features, (2) where the most and/or least of some feature exists, (3) the density of features in a given space, (4) what is happening inside an area of interest (AOI), (5) what is happening nearby some feature or phenomenon, and (6) and how a specific area has changed over time (and in what way).

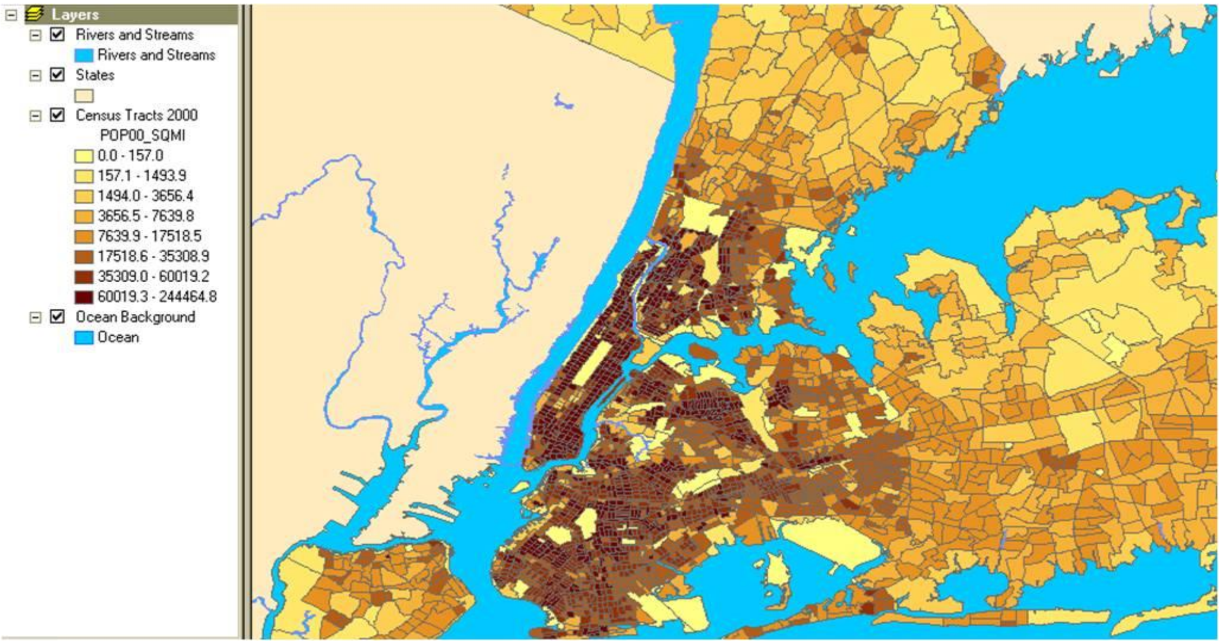
1. **Mapping where things are.** We can map the spatial location of real-world features and visualize the spatial relationships among them.
Example: below we see a map of agricultural districts (in green) layered over soil types. We can see visual patterns in the data by determining what soil types are best suited for ag districts.



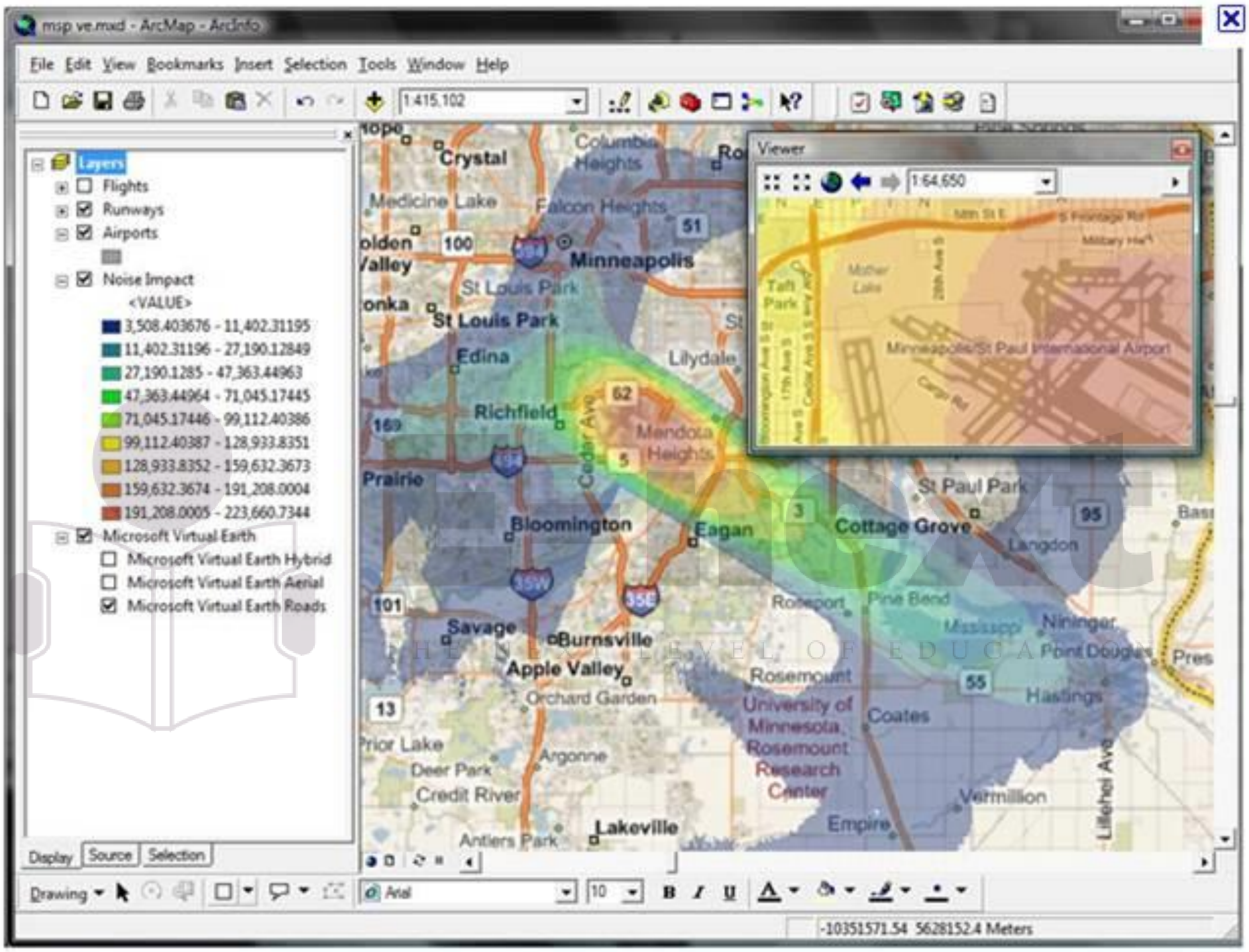
2. **Mapping quantities.** People map quantities, such as where the most and least are, to find places that meet their criteria or to see the relationships between places.
Example: below is a map of cemetery locations in Wisconsin. The map shows the cemetery locations as dots (dot density) and each county is color coded to show where the most and least are (lighter blue means fewer cemeteries).



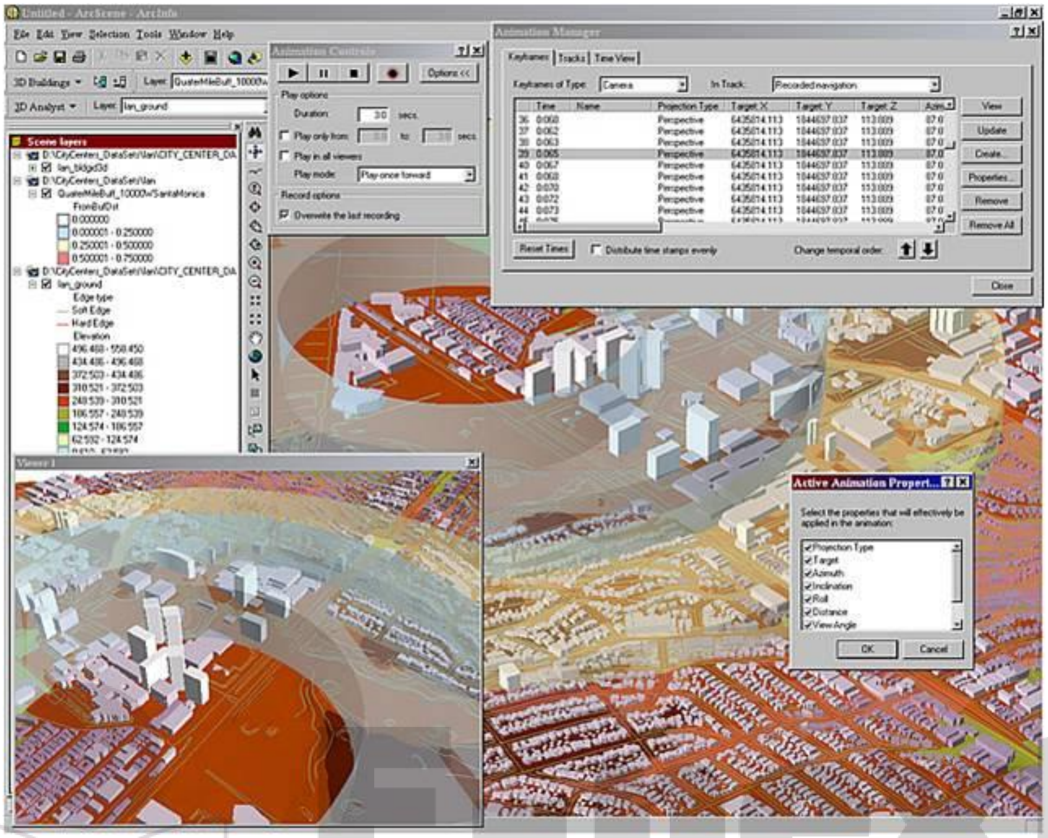
3. **Mapping densities.** Sometimes it is more important to map concentrations, or a quantity normalized by area or total number. Example: Below we have mapped the population density of Manhattan (total population counts normalized by the area in sq. miles of census tracts.)



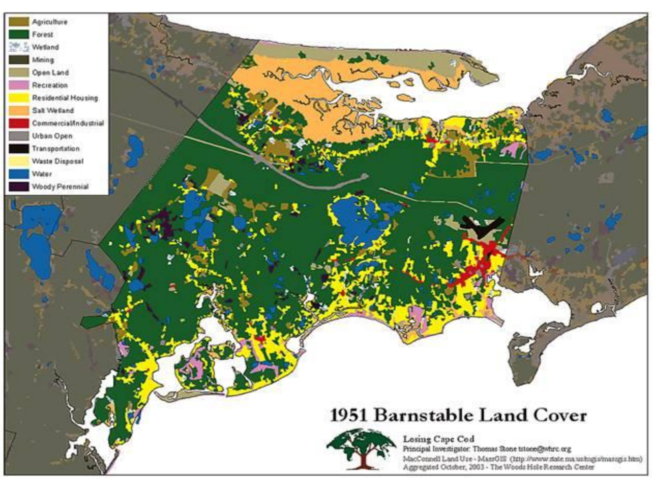
4. **Finding what is inside.** We can use GIS to determine what is happening or what features are located inside a specific area/region. We can determine the characteristics of "inside" by creating specific criteria to define an area of interest (AOI). Example: below is a map showing noise 'pollution' near an airport in Minneapolis. If we add demographic data from the Census to this map we can determine the socioeconomic characteristics of people that live within the defined 'noise pollution' area of interest.

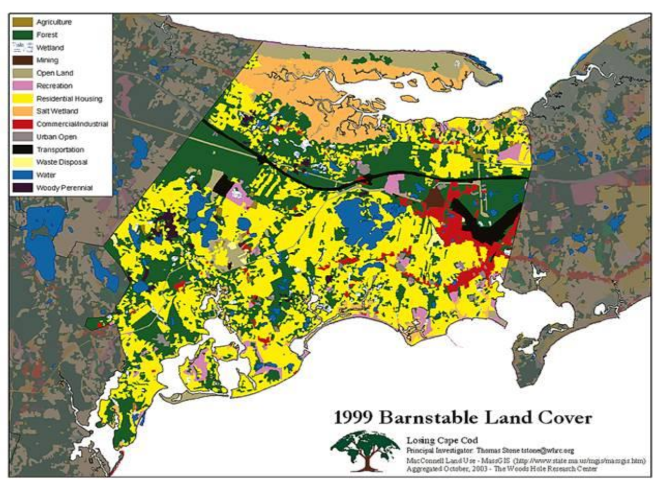


5. **Finding what is nearby.** We can find out what is happening within a set distance of a feature or event by mapping what is nearby using geoprocessing tools like BUFFER. Example: below we see the effects on features within specified radii of a simulated explosion. Use of buffering tools to generate set distances can aid in emergency response to disasters like these.

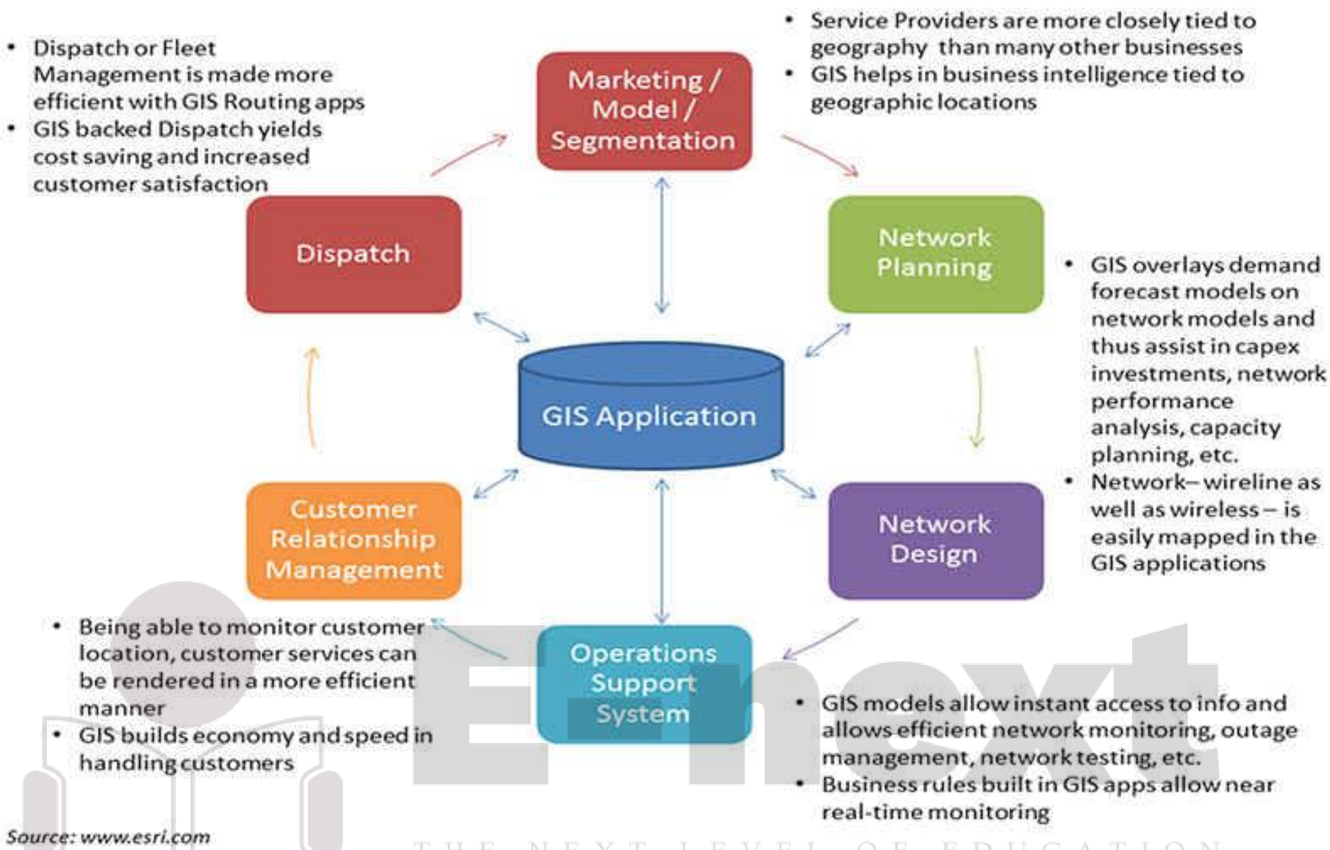


6. **Mapping change.** We can map the change in a specific geographic area to anticipate future conditions, decide on a course of action, or to evaluate the results of an action or policy. Example: below we see land use maps of Barnstable, MA showing changes in residential development from 1951 to 1999. The dark green shows forest, while bright yellow shows residential development. Applications like this can help inform community planning processes and policies.





Q-3) Explain applications of GIS. (2014)



- Natural Resources Management – inventory and management of agriculture crops, land cover and land use, forestry resources, soils, land degradation and wasteland management, water resources etc. towards establishing a Natural Resources Information System using Land Capability and Suitability models.
- Disaster Management Support – where applications of GIS for vulnerability assessment, damage assessment rehab/relief works etc. can form a foundation.
- Land records with a Land Information System (LIS) – where land records computerization with the cadastral maps can provide innovative land management solutions and public enterprises.
- Urban Management, property and taxation applications as part of an urban GIS where multi-scale GIS solutions for planning and administration of urban areas and optimizing tax collection can be enabled.
- Rural Applications of watershed management, rural roads management, village development planning and rural governance services
- Defence & Security applications – a variety of command/control, battlefield management, Image Intelligence and other critical solutions that can support police and homeland security requirements
- Aviation GIS to support Airports Asset management and air-traffic control requirements – apart from airport environment management

- Utility GIS - Telecom GIS to support fixed and mobile telecom services (including Location Based Services); Power-GIS solutions that allow effectively managing power generation, power distribution and Billing solutions
- GIS Applications for Oil and Gas – integration of geophysical, images and maps to decide where to drill, route a pipeline, or build a refinery and make the right business decisions.
- GIS Applications on Web and Wireless Systems offering GIS services on a variety of devices – internet, desktop, hand-held, mobile etc. GIS on small hand-held terminals (like PDAs) is also provided.
- 3-D GIS solutions – based on converting 2-dimensional maps, extruding the polygons to create polygon-blocks and attributing text to these polygons (from library or actual pictures) to create a 3D visualization. Such 3-D GIS solution has immense applications in Urban, Security, Tourism and Real-Estate applications.
- Other GIS Applications – Mining & Exploration, Insurance, Retail Business etc.

Q-5) Explain components of GIS. (April 2015)

GIS Hardware:-

- Hardware is the computer on which a GIS operates. Today, GIS runs on a wide range of hardware types, from centralized computer servers to desktop computers used in standalone or networked configurations.

GIS Software:-

- GIS software provides the functions and tools needed to store, analyze, and display geographic information. Key software components are
  - a database management system (DBMS)
  - tools for the input and manipulation of geographic information
  - tools that support geographic query, analysis, and visualization
  - a graphical user interface (GUI) for easy access to tools

GIS Data: -

Maybe the most important component of a GIS is the data. Geographic data and related tabular data can be collected in-house or bought from a commercial data provider. Most GISs employ a DBMS to create and maintain a database to help organize and manage data.

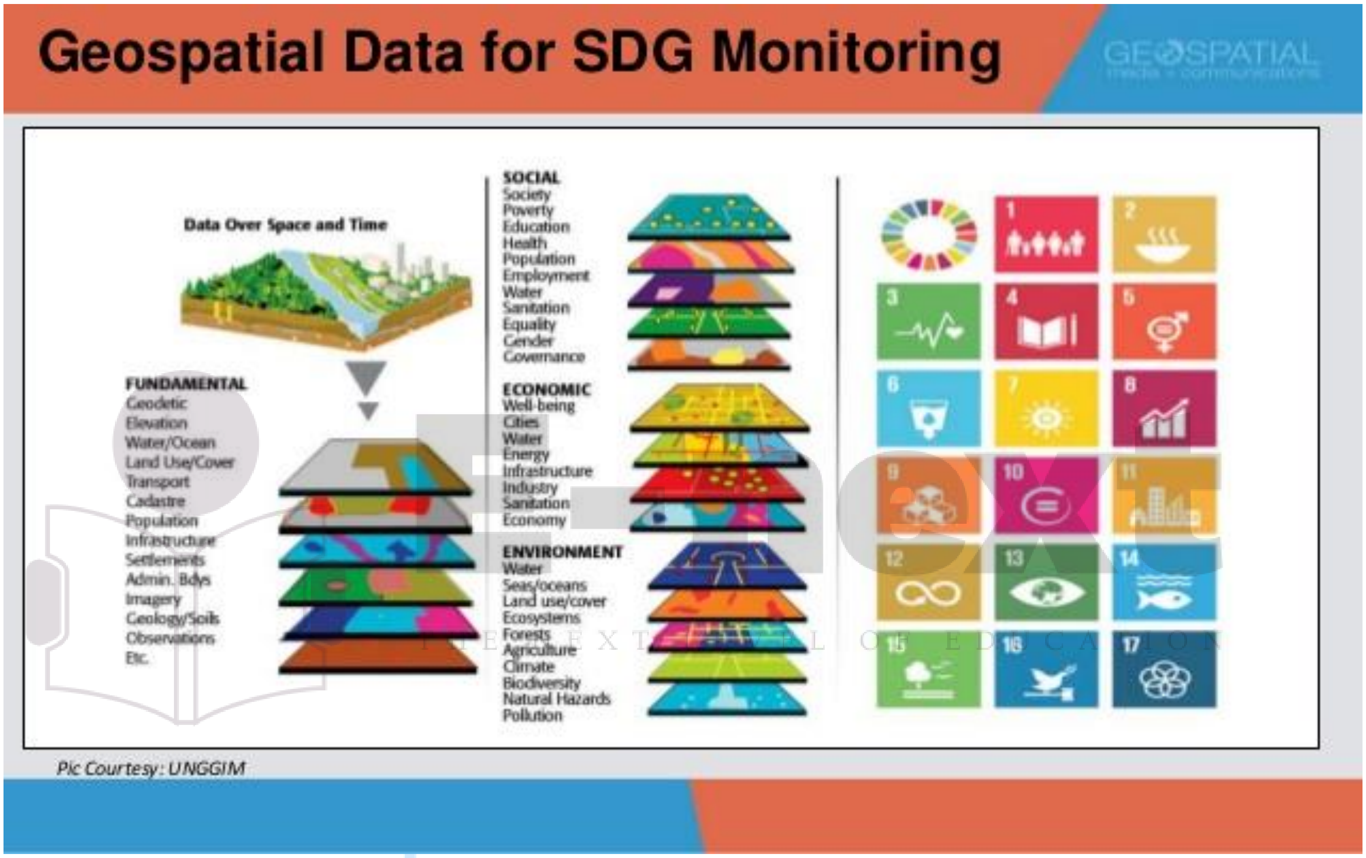
People:-

GIS technology is of limited value without the people who manage the system and to develop plans for applying it. GIS users range from technical specialists who design and maintain the system to those who use it to help them do their everyday work.

Methods:-

A successful GIS operates according to a well-designed plan and business rules, which are the models and operating practices unique to each organization.

Q-6) Geospatial Data:-

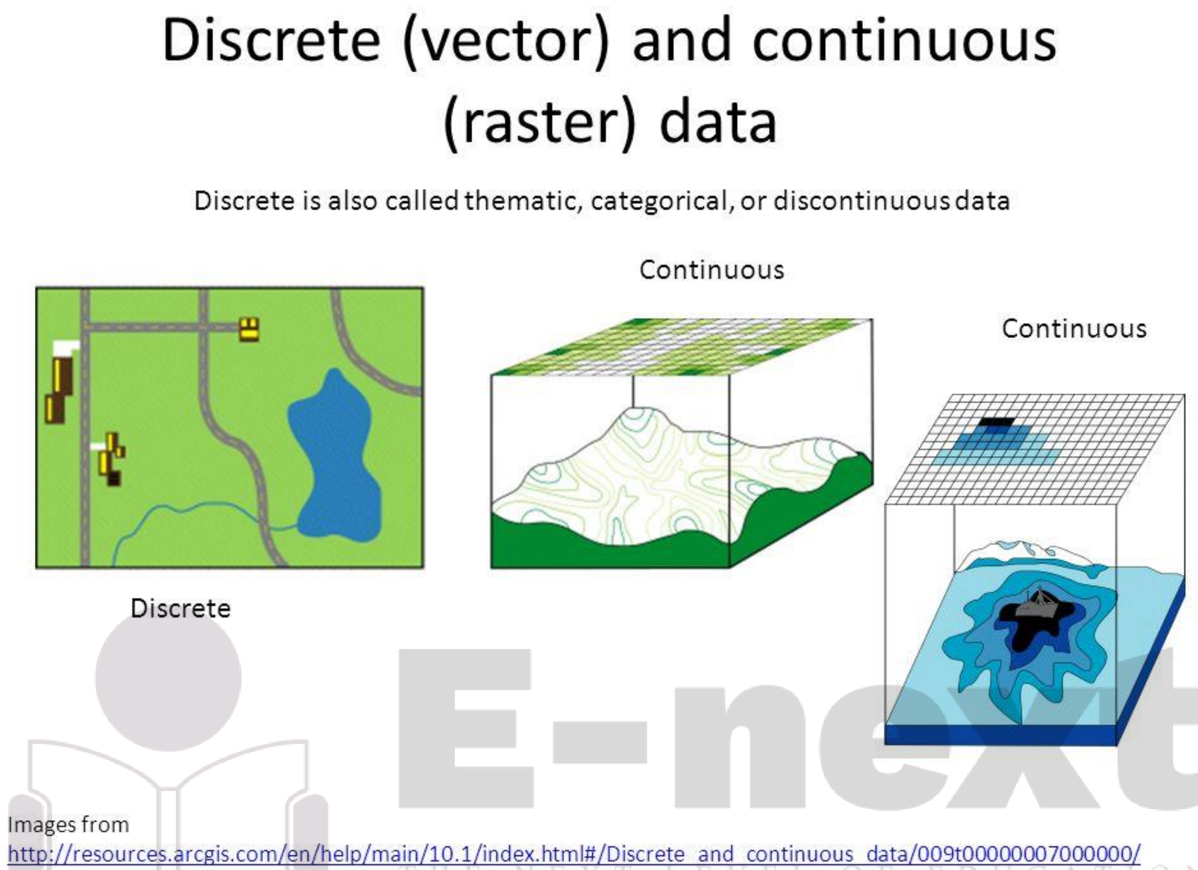


- Geospatial data are data that describe both the location and characteristics of spatial features such as roads, land parcels and vegetable stands on the earth's surface.
- The location, also called geometry or shape also represents spatial data.
- The characteristics are attribute data.
- Thus any geospatial data has the two components of spatial data and attribute data.

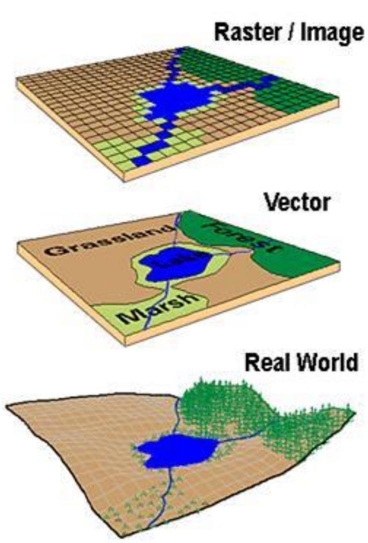
Spatial Data:-

- Spatial data describes the location of spatial feature.
- It may be discrete or continuous.
- Discrete features are individually distinguishable features that do not exist between observations. E.g. Points (e.g. Wells), lines (roads) etc. areas (state boundaries).
- Continuous features are features that exist spatially between observations. E.g. Elevations and precipitations.

- A GIS represents these spatial features on earth surface as map feature on plane surface.



Q-7) Explain the following terms:- Data Models, Topology, Projection, Attribute data, Joining Spatial and Attribute data



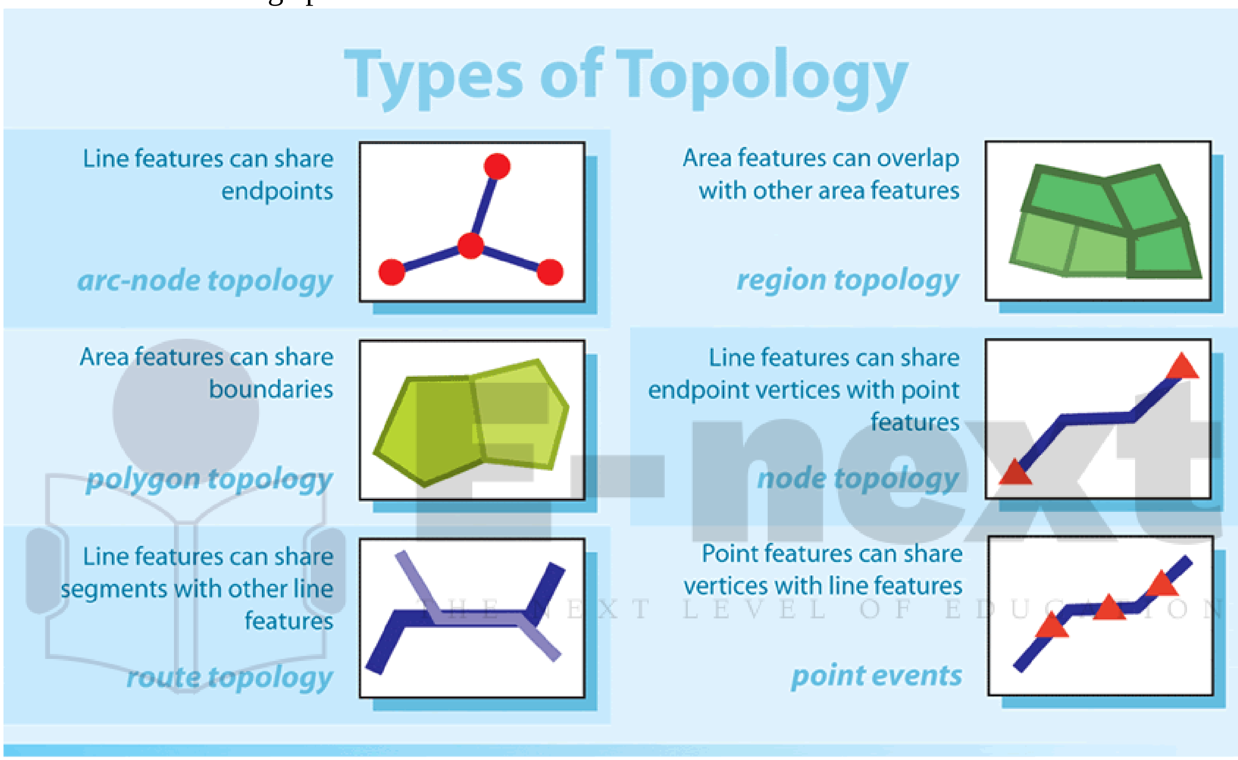
Data Models:-

- The data model defines how spatial features are represented in a GIS.
- There are two types of data models
  - ➢ Raster data model
  - ➢ Vector data model
- The Raster data model uses grid and grid cells to represent spatial variation of feature.
- The Raster data model uses simple data structure with rows, columns and fixed cell locations.
- The vector data model uses points and there x and y co-ordinates to construct spatial feature of points, lines, areas.
- The vector data model may be georelational or object based.

- The georelational data model uses a split system to store spatial data and attribute data.
- The object based data model stores spatial as well as attribute data in single system.

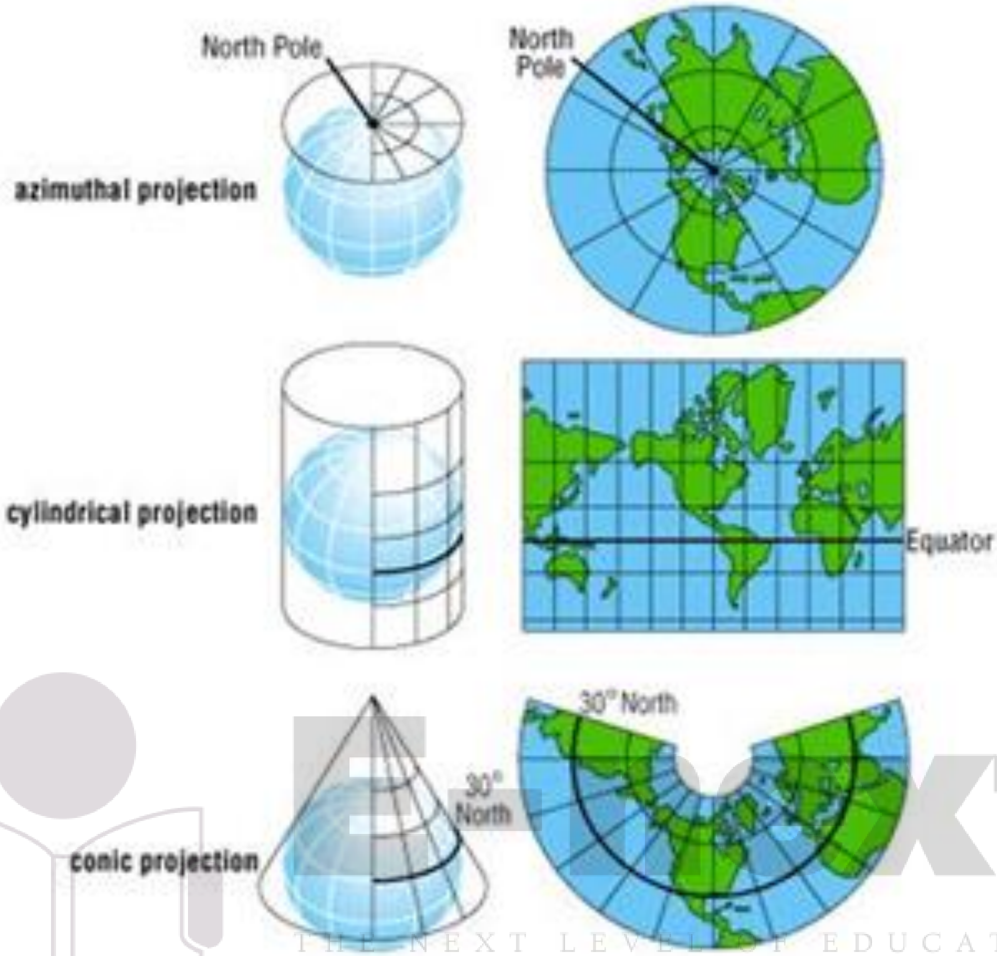
Topology:-

- Topology expresses explicitly the spatial relationships between features.
- E.g. two lines meeting perfectly at a point and a directed line having an explicitly left and right side.
- Topological or topology based data are useful for detecting and correcting digitizing errors in Geographic data sets.



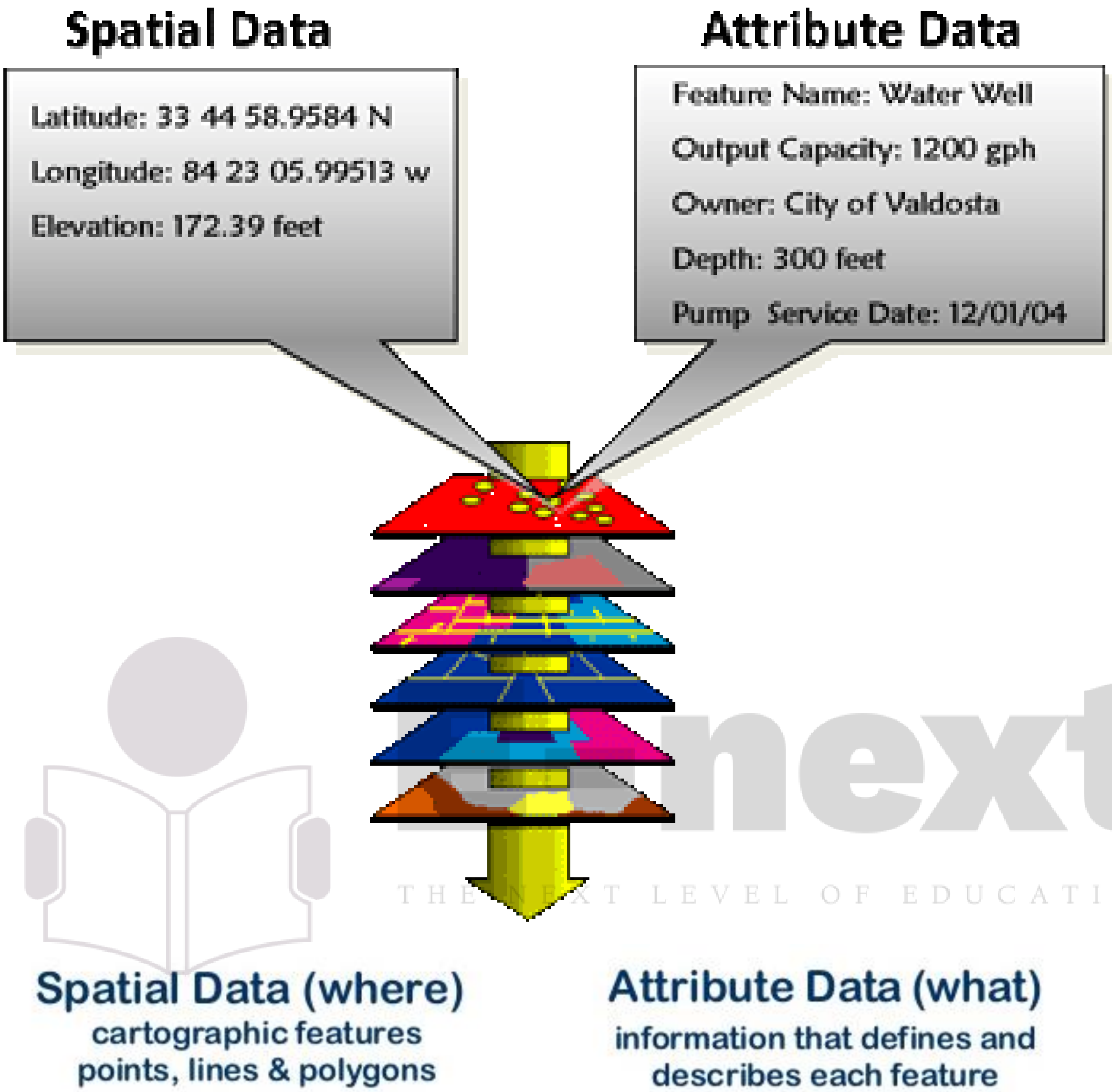
Projection:-

- Projection is a process that can transform the earth's surface to a plane surface and bridge two spatial system.
- The location of spatial features on earth's surface are based on geographic coordinate system with longitude and latitude values.
- Whereas, the location of map features are based on a plane coordinate system with x, y-coordinates.



Attribute Data:-

- Attribute data describes the characteristics of spatial features.
- For Raster data, each cell has a value that corresponds to the attribute of spatial feature at that location.
- A cell is tightly bound to its cell value.
- For vector data, the amount of attribute data to be associated with a spatial feature can vary significantly.



Joining Spatial and Attribute data:-

- The georelational data model stores attribute data separately from spatial data in a split system.
- The two features are linked through Feature IDs.
- The object based data model stores spatial data as an attribute data along with other attributes in a single system.
- Thus the Object based data model eliminates the complexity of coordinating and synchronizing two sets of data files as required in a split system.

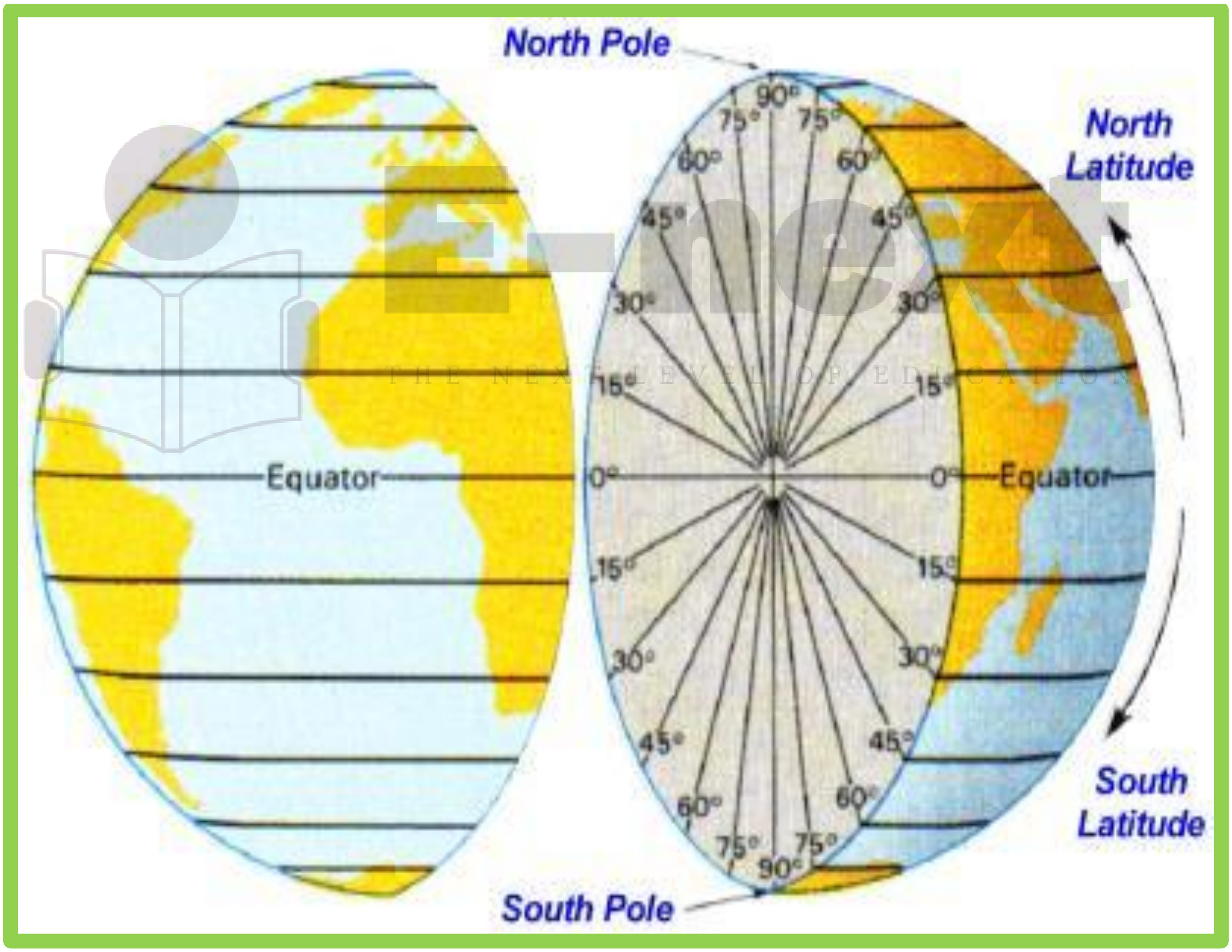
Q-8) Explain Coordinate System.

Coordinate System:-

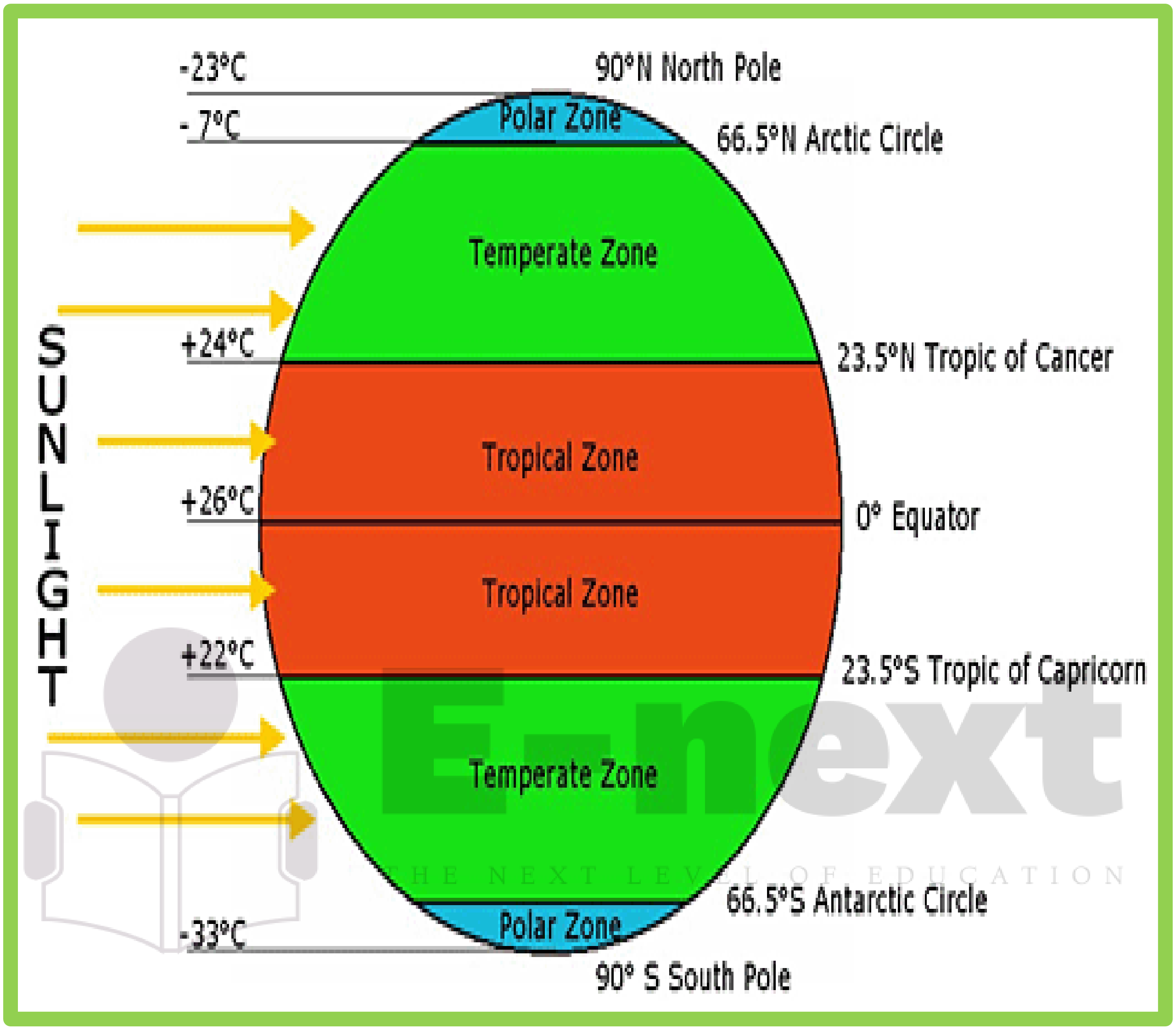
- A coordinate system is a reference system used for locating objects in a two or three dimensional space

Geographic Coordinate System

- A geographic coordinate system, also known as global or spherical coordinate system is a reference system that uses a three-dimensional spherical surface to determine locations on the earth. Any location on earth can be referenced by a point with longitude and latitude.
- We must familiarize ourselves with the geographic terms with respect to the Earth coordinate system in order to use the GIS technologies effectively.



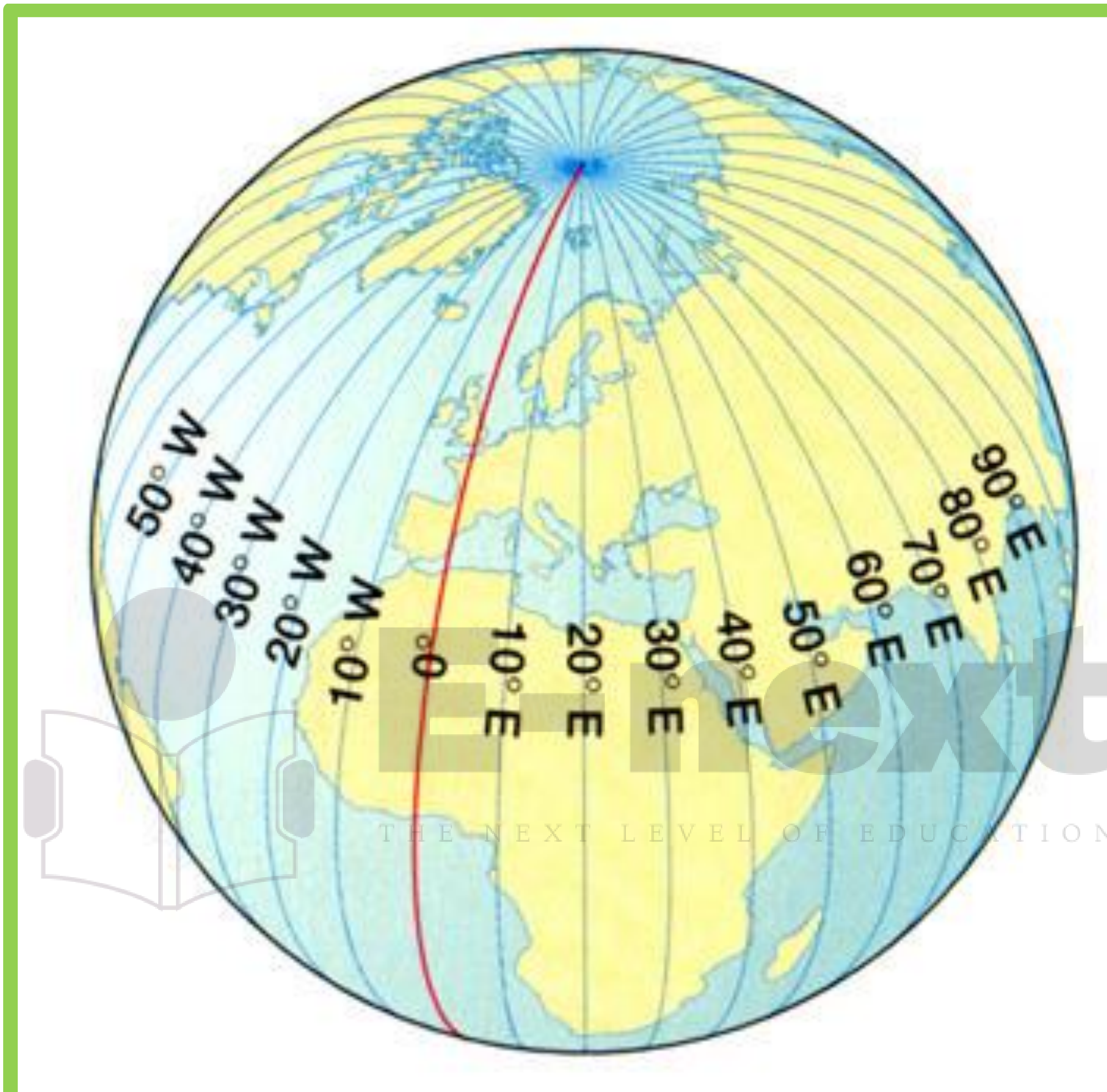
- Latitudes =angular distance of a place from the equator
- All latitudes are concentric circles
- They are called parallels as well



- Largest latitude – equator
- Tropics – heat surplus
- Temperate, polar regions – heat deficit
- Responsible for pressure system and planetary wind system

Pole:
 The geographic pole of earth is defined as either of the two points where the axis of rotation of the earth meets its surface.
 The North Pole lies 90o north of the equator and the South Pole lies 90o south of the Equator

Equator:
 An imaginary line on the earth with zero degree latitude, divides the earth into two halves–Northern and Southern Hemisphere.
 This parallel has the widest circumference.

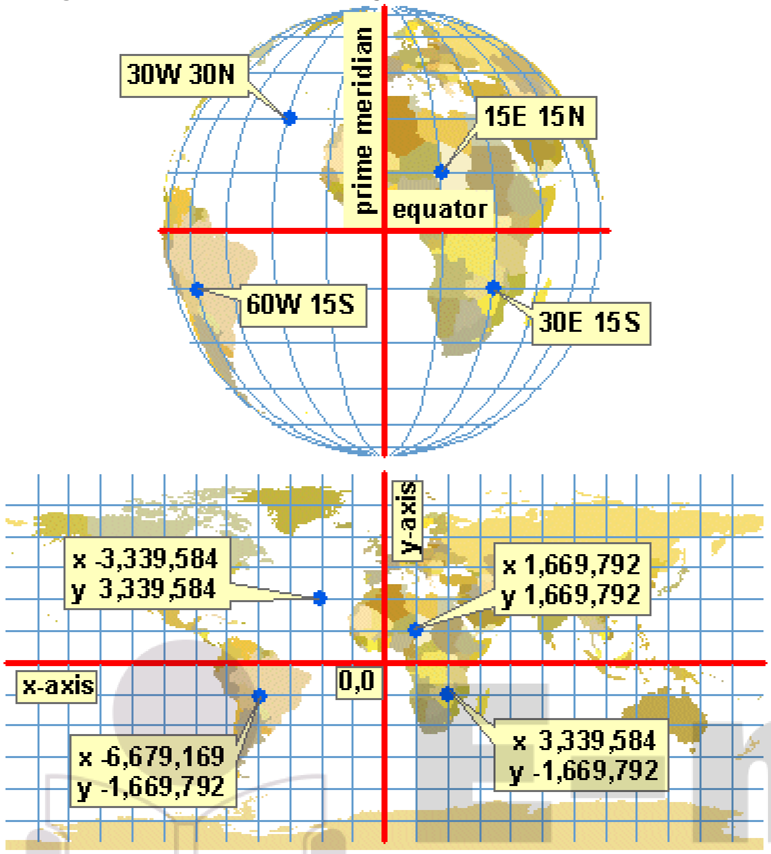


- Angular distance of a place from prime meridian
- Also called meridians
- 0 degree = Greenwich in UK
- 180 degree = International date line

Datum:-

- A Datum is the mathematical model of earth, which serves as the reference or base for calculating the geographic coordinates of a location.

Projected Coordinate system:-



- A projected coordinate system is defined as two dimensional representation of the Earth.
- It is based on a spheroid geographic coordinate system, but it uses linear units of measure for coordinates.
- It is also known as Cartesian coordinate system or plane coordinate system.
- In such a coordinate system the location of a point on the grid is identified by (x, y) coordinate pair and the origin lies at the centre of grid.
- The x coordinate determines the horizontal position and y coordinate determines the vertical position of the point.

Map Projections:- (2014)

- The process of projection transforms the spherical earth's surface to a plane.
- The outcome of this transformation process is map projection.
- Map projection is the systematic arrangement of parallels and meridians on a plane surface representing the geographic coordinates.

Types of Map projections:-

- Map projections can be grouped in two ways based on their preserved property or the projection surface.
- On the basis of preservation property Map projections are classified in four classes
- Conformal Projection
  - Equivalent Projection
  - Equidistant Projection
  - Azimuthal Projection

Conformal Projection:-

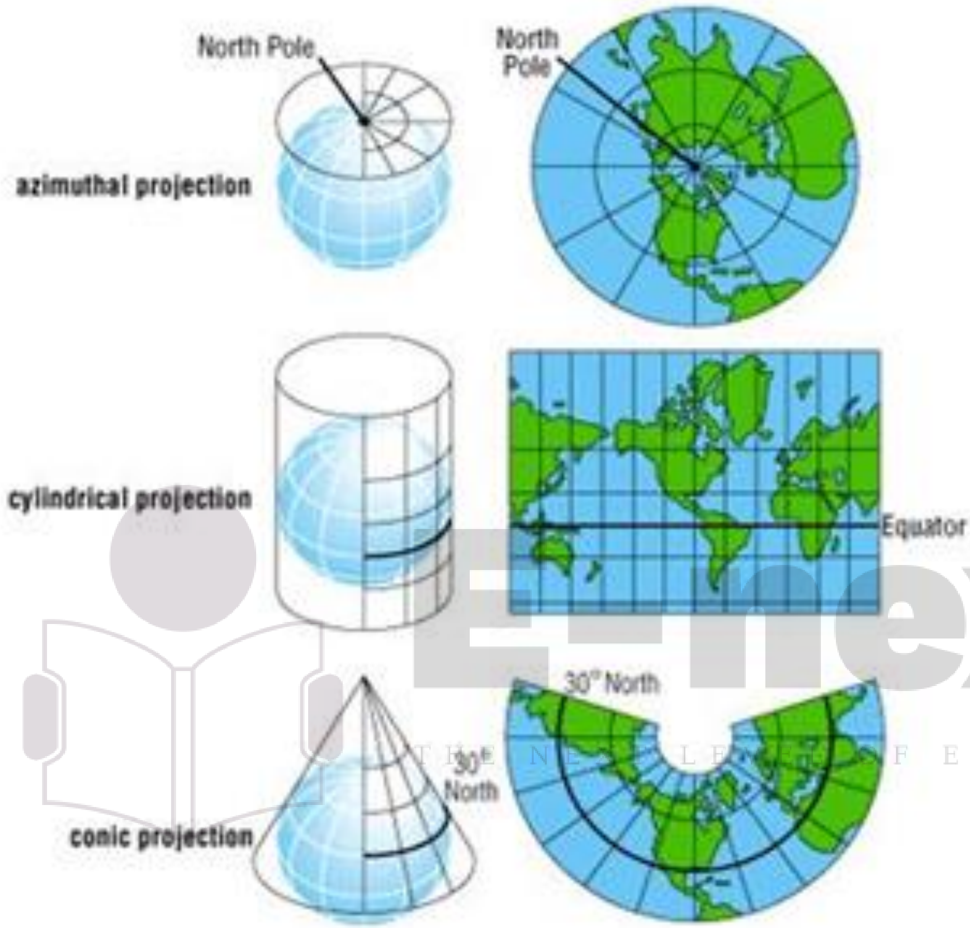
- A Conformal projection preserves local angles and shapes.

Equivalent Projection:-

- An Equivalent Projection represents areas in correct relative size.

Equidistant Projection:-

- An Equidistant projection preserves consistency of scale along certain lines.



Azimuthal Projection:-

An azimuthal projection retains certain accurate directions.

- The conformal and equivalent properties are mutually exclusive.
- The conformal and equivalent properties are global properties, meaning that they apply the entire map projection.
- The equidistant and azimuthal properties are local properties and may be true from or to the center of map projections.
- The preserved property is important for selecting an appropriate map projection for thematic mapping.
- E.g. A population map of world should be based on an equivalent projection. By representing areas in correct size, the population map can create a correct impression of population densities.
- In contrast an equidistant projection would be better for mapping the distance ranges from missile site.

Based on development surface Map projections are grouped in

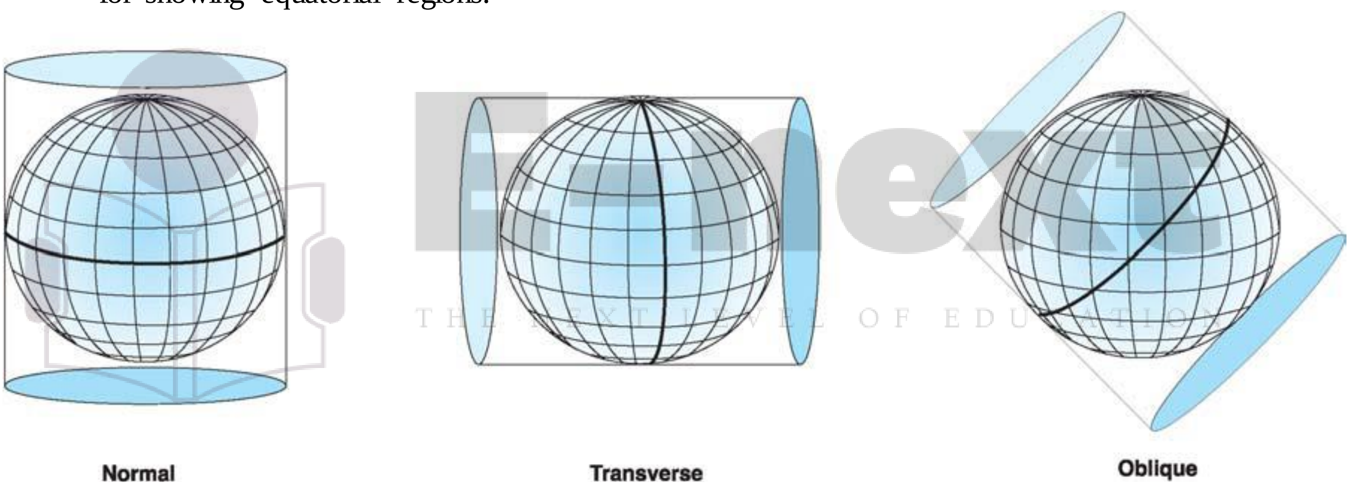
- Cylindrical Projections
- Conic projections
- Azimuthal projections

Development Surface

Projection transforms the coordinates of earth on to a surface that can be flattened to a plane without distortion (shearing or stretching). Such a surface is called a developable surface. The three basic projections are based on the types of developable surface and are introduced below:

Cylindrical Projection

- It can be visualized as a cylinder wrapped around the globe.
- Once the graticule is projected onto the cylinder, the cylinder is opened to get a grid like pattern of latitudes and longitudes.
- The longitudes (meridians) and latitudes (parallels) appear as straight lines
- Length of equator on the cylinder is equal to the length of the equator therefore is suitable for showing equatorial regions.

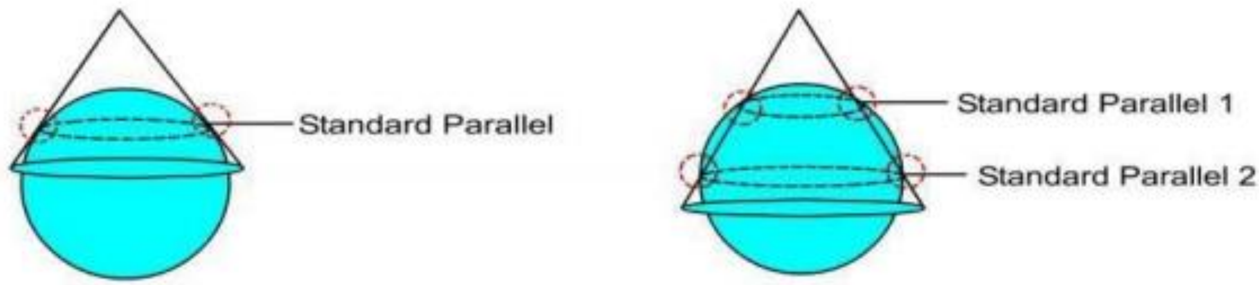


- Normal: when cylinder has line of tangency to the equator. It includes Equirectangular Projection, the Mercator projection, Lambert's Cylindrical Equal Area, Gall's Stereographic Cylindrical, and Miller cylindrical projection.
- Transverse: when cylinder has line of tangency to the meridian. It includes the Cassini Projection, Transverse Mercator, Transverse cylindrical Equal Area Projection, and Modified Transverse Mercator.
- Oblique: when cylinder has line of tangency to another point on the globe. It only consists of the Oblique Mercator projection.

Conic Projection

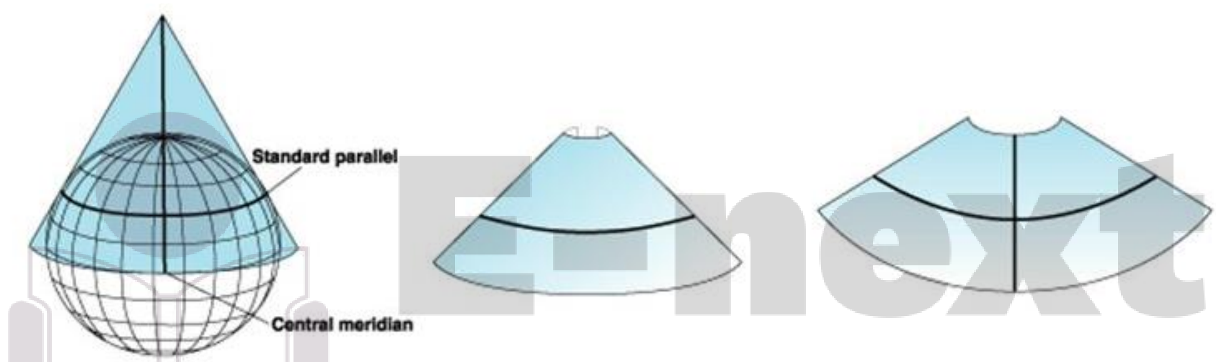
- It can be visualized as a cone placed on the globe, tangent to it at some parallel.
- After projecting the graticule on to the cone, the cone is cut along one of the meridian and unfolded. Parallels appear as arcs with a pole and meridians as straight lines that converge to the same point.
- It can represent only one hemisphere, at a time, northern or southern.

- Suitable for representing middle latitudes.



(a) (b)

- **Tangent:** when the cone is tangent to only one of the parallel.
- **Secant:** when the cone is not big enough to cover the curvature of earth, it intersects the earth twice at two parallels.

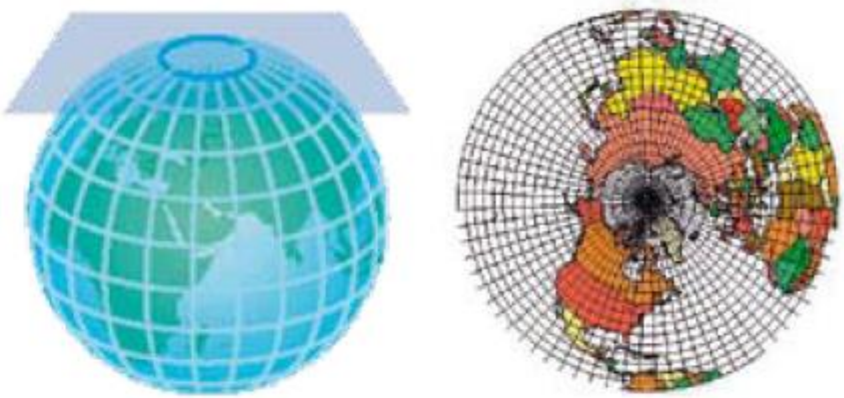


Conic (tangent)

Conic (secant)

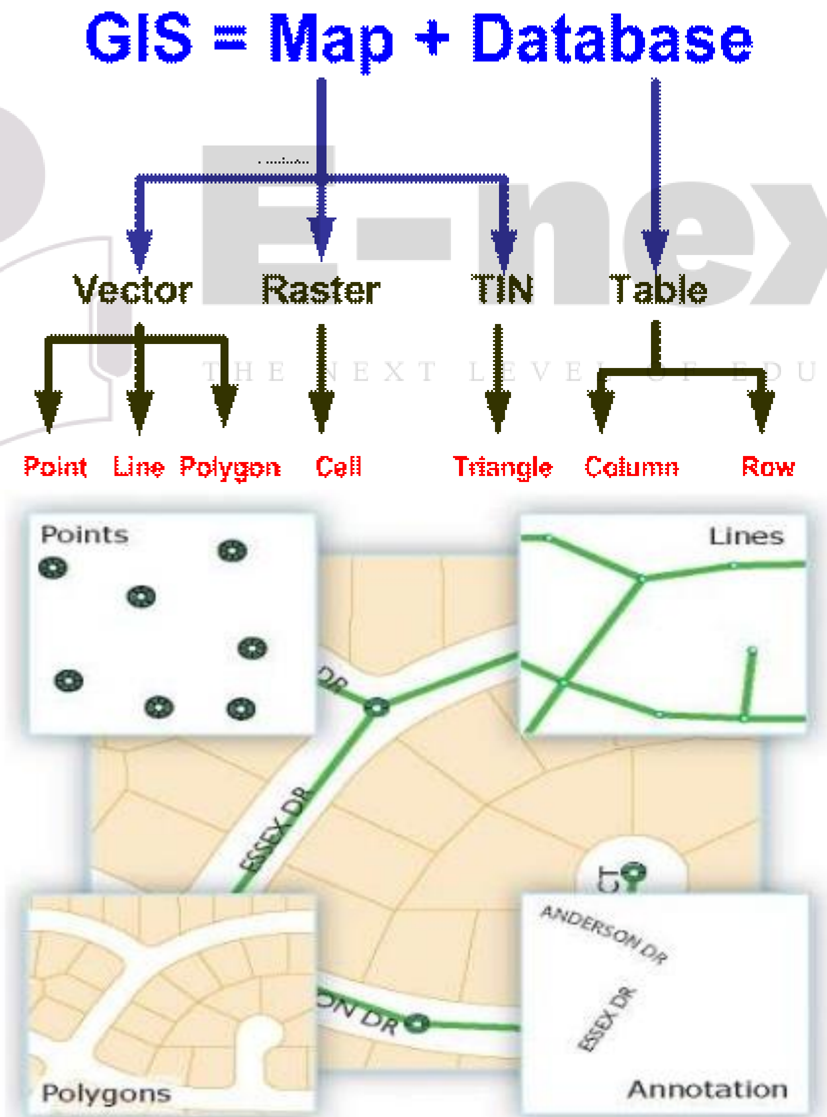
Azimuthal/Zenithal Projection

- It can be visualized as a flat sheet of paper tangent to any point on the globe
- The sheet will have the tangent point as the center of the circular map, where meridians passing through the center are straight line and the parallels are seen as concentric circle.
- Suitable for showing polar areas



Vector data model:-

- Vector Data uses Points and their (X,Y) coordinates to represent spatial features
- Points, Lines and Polygons



Points:-

- A point is a 0 dimensional object and has only the property of location (x,y)
- Points can be used to Model features such as a well, building, power, pole, sample location etc.

Lines:-

- A line is a one-dimensional object that has the property of length.
- One dimensional
- A line has two end points and points in between to mark the shape of line.
- The shape of a line may be smooth curve or a collection of straight line segments.
- Line is also called edge, link, and chain.
- Lines can be used to represent road, streams, faults, dikes, maker beds, boundary, contacts etc.

Polygons:-

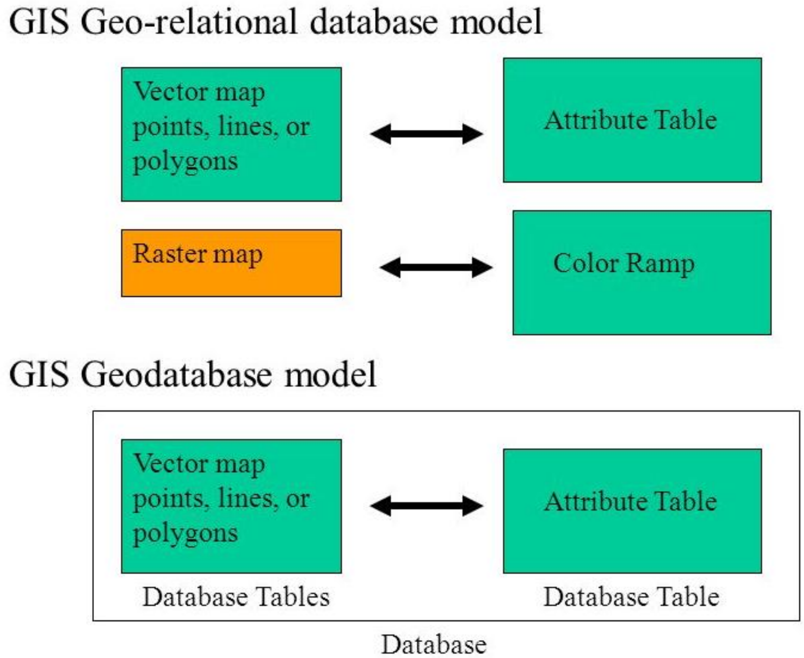
- A polygon is a two-dimensional object with properties of area and perimeter.
- Two dimensional
- Made up of connected lines
- A polygon can represent a city, geologic formation, dike, lake, river, etc.
- The vector data model prepares data in two basic steps so that computer can process the data.
- First it uses points and their x, y co-ordinate to represent spatial features such as points, Line and area.
- Second, it organises the geometric objects and their spatial relationships into digital data file that the computer can access, interpret, process.

Vector data model can be presented in two data models based on the system

- Geo relational data model
- object based vector data model

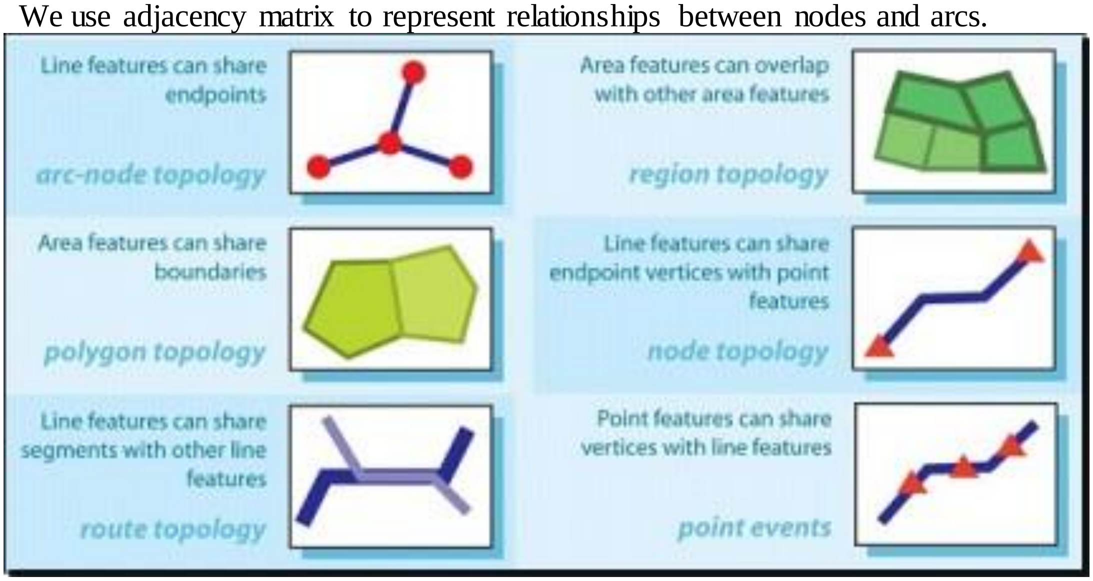
Geo relational data model:-

- Georelational data model stores spatial and attribute data separately in a split system ie. Two different databases.
- Geo(Spatial data)
- Relational(attribute data)



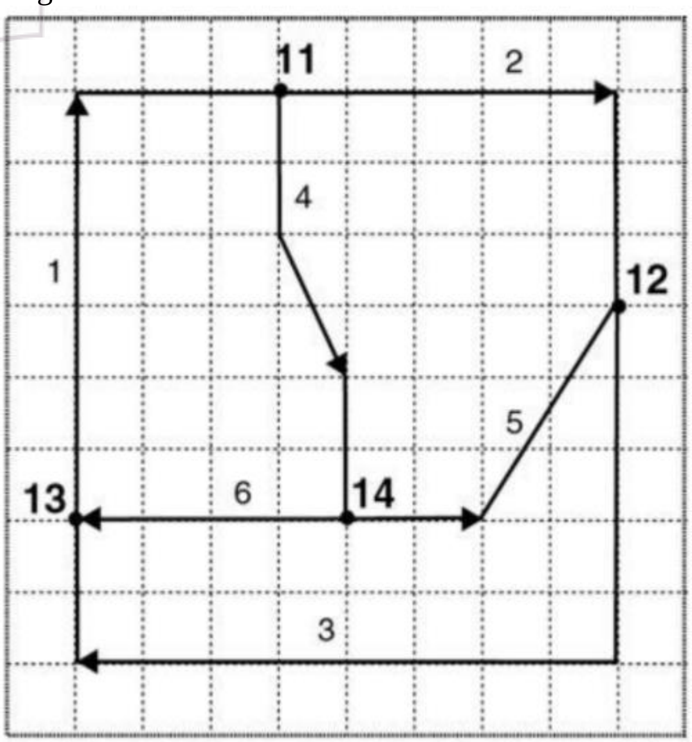
Topology:-

- The Science of mathematics of relationships used to validate the geometry of vector entities, and for operations such as network tracing and tests of polygon adjacency.
- The study of geometric properties that do not change when the forms are bent, stretched or undergo similar geometric transformations.
- A set of rules on how objects relate to each other
- Expresses explicitly (directly) the spatial relationships between features.
- In Vector data model digraphs (Directed graphs) are used to represent topology.
- Digraphs includes points and lines.
- The directed line are called arcs.
- The points where arc meets are called nodes.
- We use adjacency matrix to represent relationships between nodes and arcs.



Why Topology Matters?

- Error Detection
- Network Modeling



Adjacency matrix

	11	12	13	14
11	0	1	0	1
12	0	0	1	0
13	1	0	0	0
14	0	1	1	0

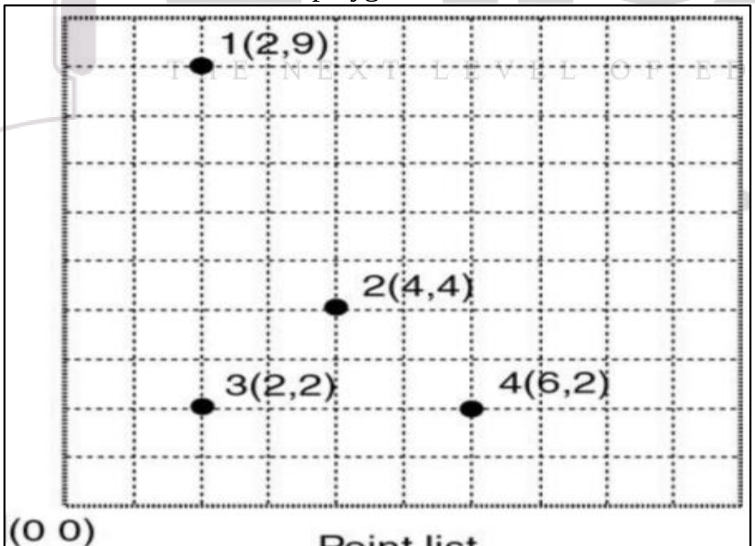
Incidence matrix

	1	2	3	4	5	6
11	−1	1	0	1	0	0
12	0	−1	1	0	−1	0
13	1	0	−1	0	0	−1
14	0	0	0	−1	1	1

Adjacency matrix and incidence matrix for a digraph

Data Structure:-

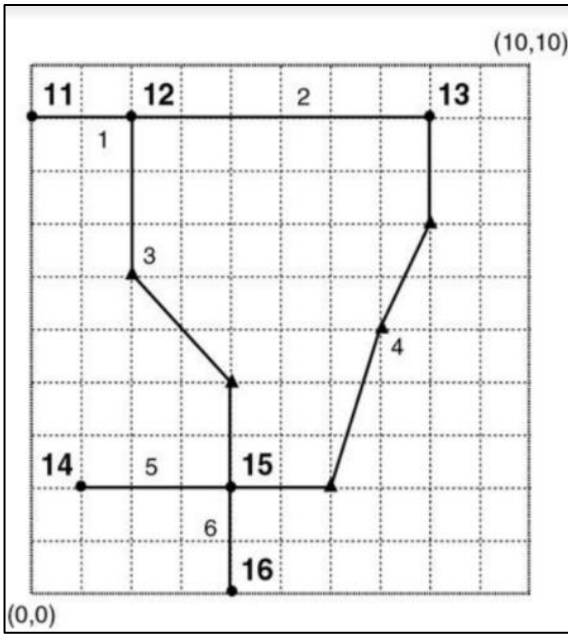
- The coverage model incorporates the topological relationship into structure of the feature data.
- The coverage data structure of point feature is simple.
- It contains feature identification number (ID) and pairs of x- and y- coordinates. The data structure for point coverage is shown in figure DS1.
- The data structure for line coverage is shown in figure DS2.
- The starting point of an arc is from node and the end point to node.
- The arc node list sorts out the arc node relation.
- As it can be seen in figure DS2 that 12 is the from-node and 13 is the to-node. (Sorted order)
- Figure DS3 shows the data structure for polygon coverage.
- The polygon/arc list shows the relationship between polygons and arcs.
- For e.g. 1,4 and 6 connect to define polygon 101.



Point list

ID	*x,y*
1	2,9
2	4,4
3	2,2
4	6,2

Fig.DS1 The data structure of point coverage



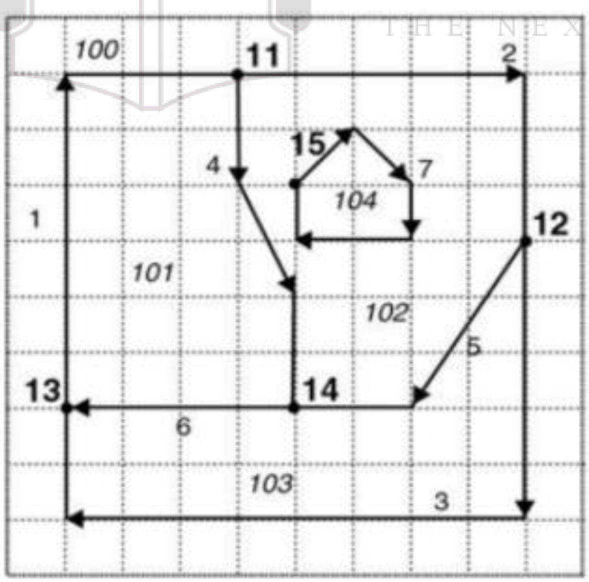
Arc-node list

Arc#	F-node	T-node
1	11	12
2	12	13
3	12	15
4	13	15
5	15	14
6	15	16

Arc-coordinate list

Arc#	x,y Coordinates
1	(0,9) (2,9)
2	(2,9) (8,9)
3	(2,9) (2,6) (4,4) (4,2)
4	(8,9) (8,7) (7,5) (6,2) (4,2)
5	(4,2) (1,2)
6	(4,2) (4,0)

Fig DS2 data structure for line coverage



Left/right list

Arc#	L-poly	R-poly
1	100	101
2	100	102
3	100	103
4	102	101
5	103	102
6	103	101
7	102	104

Polygon/arc list

Polygon #	Arc#
101	1,4,6
102	4,2,5,0,7
103	6,5,3
104	7

Arc-coordinate list

Arc#	x,y Coordinates
1	(1,3) (1,9) (4,9)
2	(4,9) (9,9) (9,6)
3	(9,6) (9,1) (1,1) (1,3)
4	(4,9) (4,7) (5,5) (5,3)
5	(9,6) (7,3) (5,3)
6	(5,3) (1,3)
7	(5,7) (6,8) (7,7) (7,6) (5,6) (5,7)

Fig DS3 the data structure for polygon coverage

Object based vector data model:

- Stores spatial data and attribute data together in a single system.
- The object based data model uses objects to represent and organize spatial features.
- The spatial data (geometry) is stored as an attribute along with other attributes.
- So we have single system which stores both spatial as well as attribute data.
- The object based data model treats spatial data as object.
- Users can add behavior, properties, rules and relationships to data
- Implemented as extension to standard relational database technology
- Supports topologically integrated feature classes
- Extends the coverage model with support for complex networks, relationships among feature classes, and other object-oriented features

Objectid	Shape	Landuse_ID	Category	Shape_Length	Shape_Area
1	Polygon	1	5	14,607.7	5,959,800
2	Polygon	2	8	16,979.3	5,421,216
3	Polygon	3	5	42,654.2	21,021,728

Object based vector data model

- An object can represent a spatial feature such as road.
- In Object based data model the spatial data are stored as special field using a data type called BLOB (Binary large object).
- Each Object have properties and methods.
- Properties represent attribute or characteristic.
- Methods perform specific action.

Objects & Object Classes

- A class is a set of objects with similar attribute.
- Geodatabases organize geographic data into a hierarchy of data objects.
- Objects are instances of an object class that have properties and behavior.
- E.g. A class called feature can cover point, line and polygon feature objects.
- The feature class defines the same properties and same methods for all objects.
- Objects can be related to other objects via relationships
- Objects have unique system identifiers (OID)
- Object classes are tables in a geodatabase storing non-spatial data (e.g., Parcel owners)
- Objects in an object class have the same
- Properties - stored in the table as attributes
- Behavior - implemented as a component

Data Structures

- The Geodatabase model distinguishes between “feature class” and “feature dataset”.
- A feature class spatial data of same geometry type.

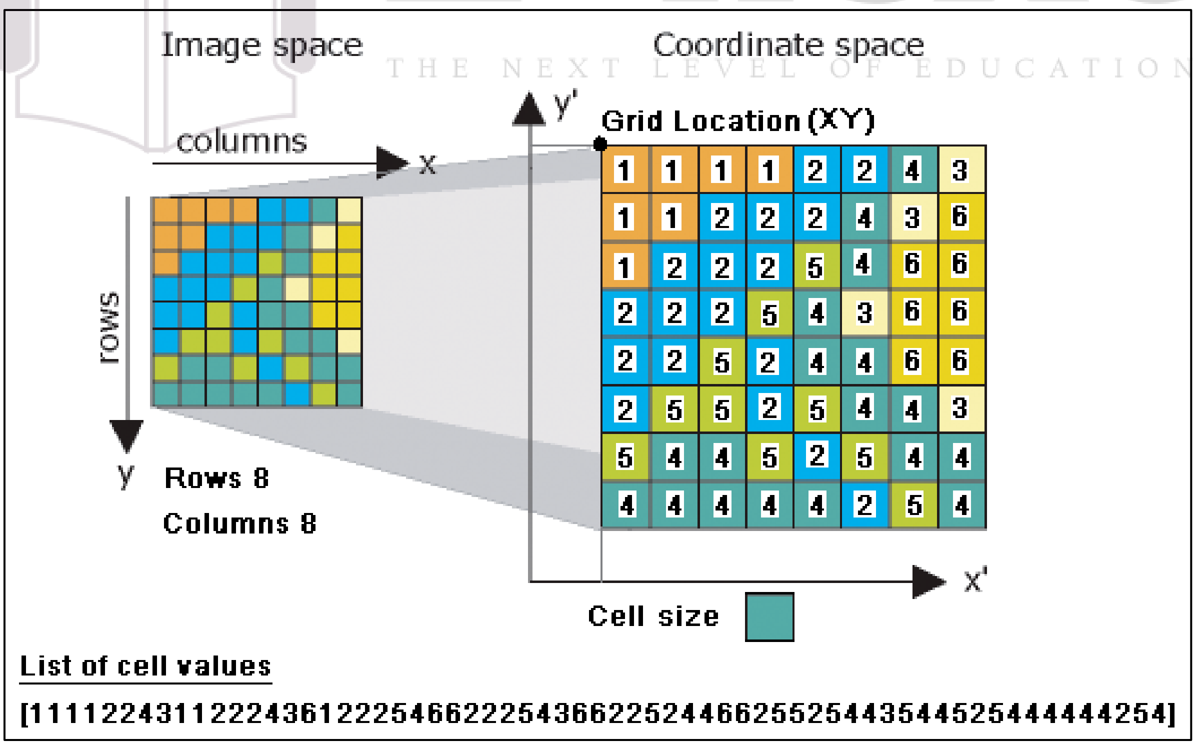
- A feature dataset stores classes that share same coordinate system and are extent.

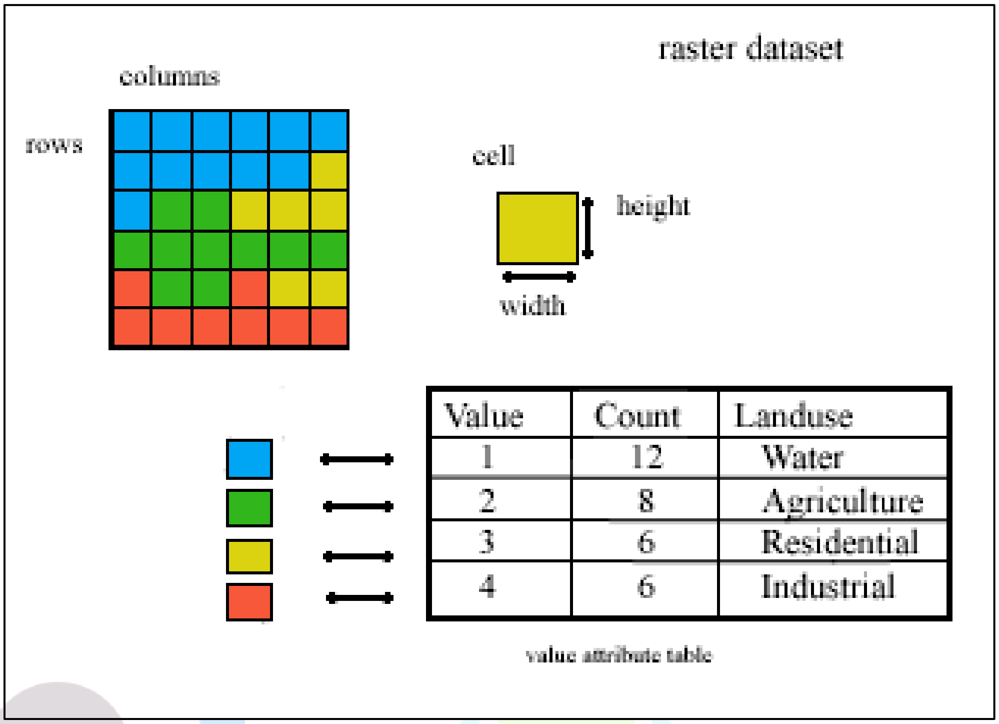
Features and Feature Classes

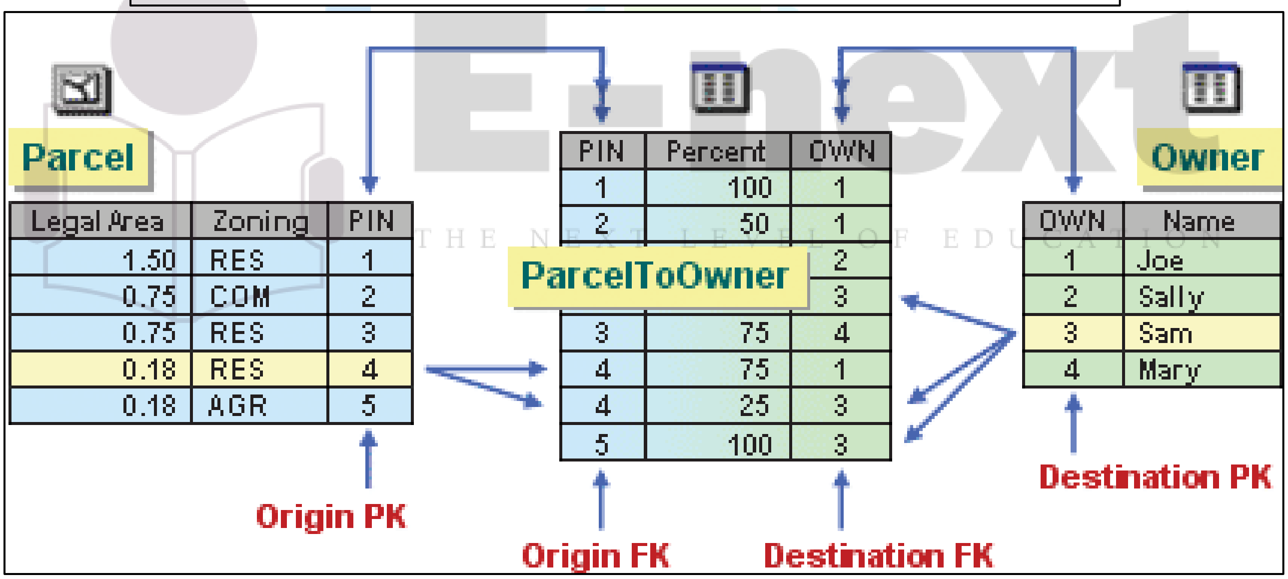
- Features are objects with required shape (Points, Multi-points, Lines & Polygons) that represent a real world object in a layer on a map.
- Features classes are collections of features with same type of feature geometry and attributes.
- A feature class is also an object class which stores spatial objects (features) (e.g., Parcels).
- All the features in a feature class are in the same spatial reference.
- Feature classes which store topological features must be contained within a feature dataset to ensure a common spatial reference.

Raster Data Model:-

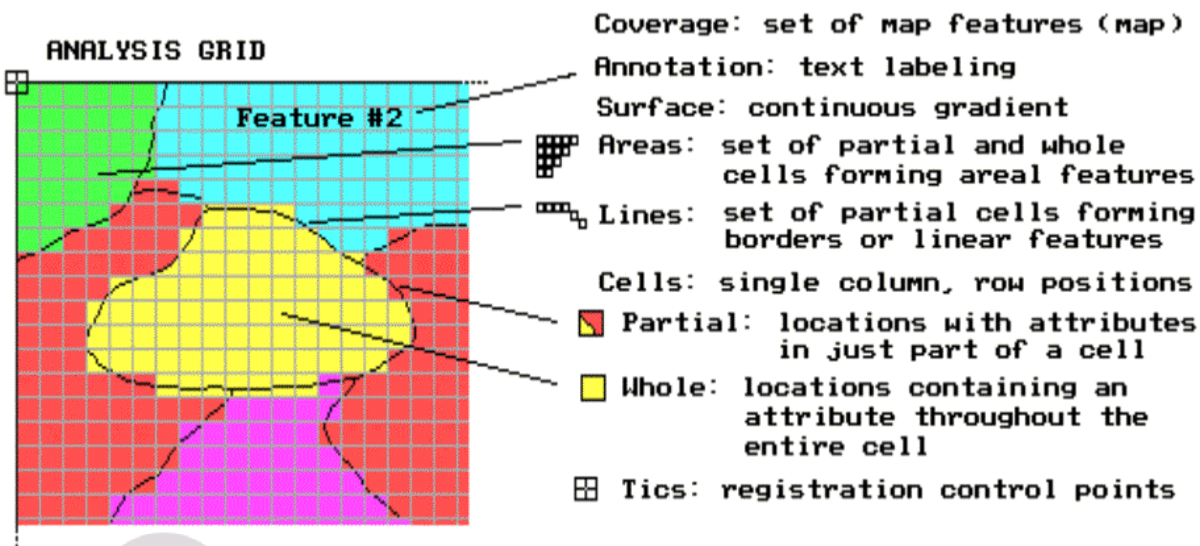
- Data are divided into cell, pixels, or elements
- Cells are organized in arrays
- Each cell has a single value
- Row and Column Numbers are used to identify the location of the cell within the array.
- Perhaps the most common example of raster data is a digital image.
- As the vector data model does not work well with spatial phenomenon that vary continuously over the space such as precipitation, elevation, soil erosion.
- Raster data model is a better option to represent continuous phenomenon.

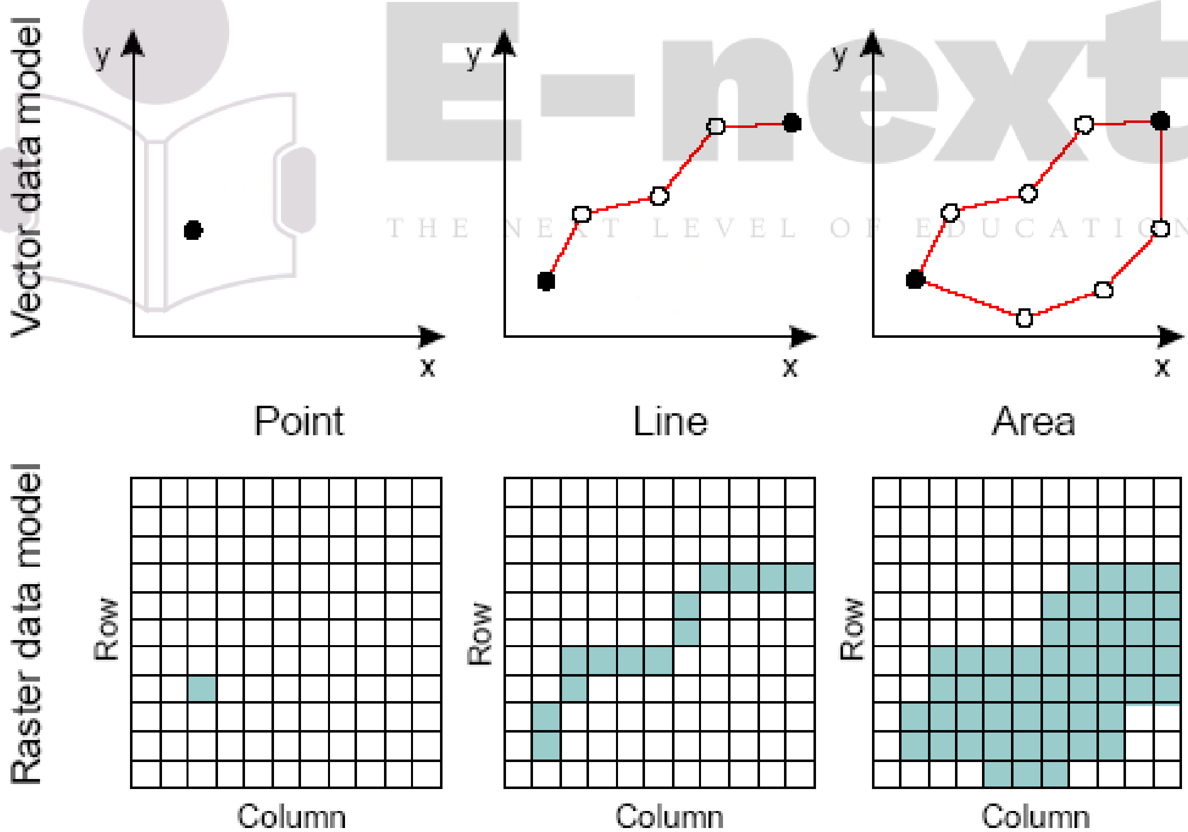



raster dataset
columns
rows
cell
height
width
Value | Count | Landuse
1 | 12 | Water
2 | 8 | Agriculture
3 | 6 | Residential
4 | 6 | Industrial
value attribute table


Parcel
Legal Area | Zoning | PIN
1.50 | RES | 1
0.75 | COM | 2
0.75 | RES | 3
0.18 | RES | 4
0.18 | AGR | 5
ParcelToOwner
PIN | Percent | OWN
1 | 100 | 1
2 | 50 | 1
2
3
3 | 75 | 4
4 | 75 | 1
4 | 25 | 3
5 | 100 | 3
Owner
OWN | Name
1 | Joe
2 | Sally
3 | Sam
4 | Mary
Origin PK
Origin FK
Destination FK
Destination PK

GIS MAP STRUCTURE (Raster)





Elements of Raster data model:-

Cell value:-

- Each cell in the raster carries a value.
- Cell represents the characteristic of a spatial phenomenon at a location denoted by its row and column.
- Depending upon the coding of its cell values, a raster can be either an integer or a floating point raster.
- An integer value has no decimal digits, whereas a floating point value does.
- Integer Raster:-
  o Has no decimal digit
  o It represents integer data.
  o It represents categorical data which may or may not be ordered.
- Floating point raster:-
  o Represents continuous, numeric data.

Cell Size:-

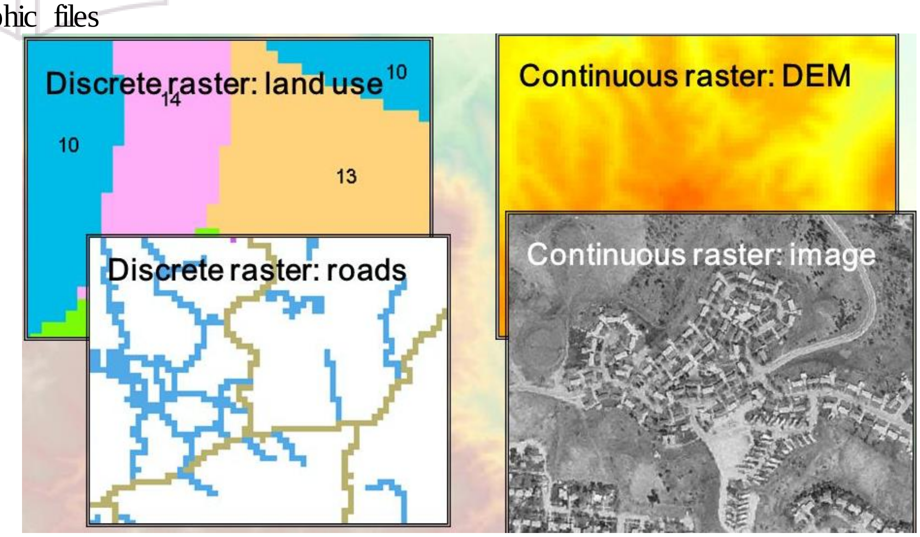
- It represents resolution of raster data model.

Raster Bands:-

- A raster may have single band or multiple band.
- Each cell in a multiband raster is associated with more than one cell value. Eg.Satellite image which may have five, seven, or more cell values at each location.
- In single band raster each cell has only one cell value.eg. Elevation

Types of raster data:-

- Satellite Imagery
- Graphic files

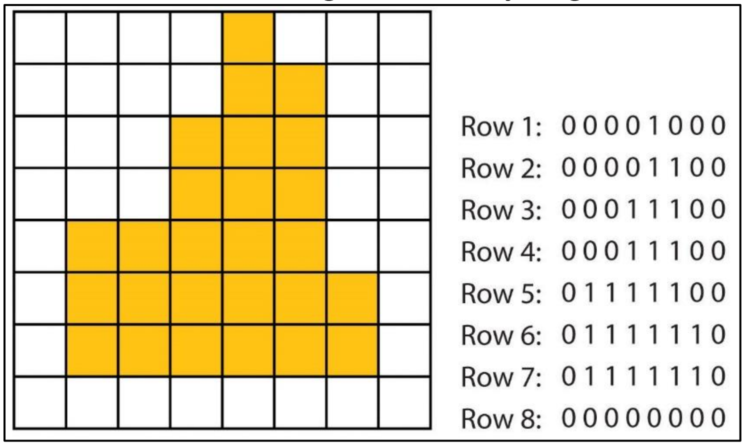


Raster Data Structure:-

- Cell by cell encoding
- Run length encoding
- Quad tree

Cell by cell encoding:-

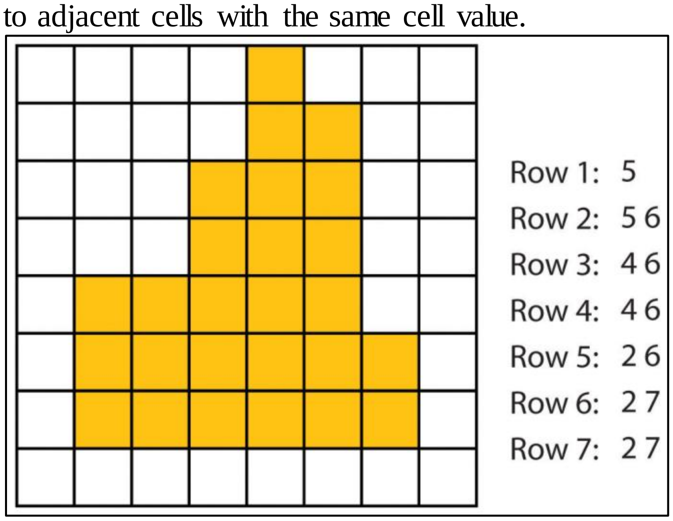
- A raster is stored as a matrix and its cell values are written in a file by row and column number.
- A raster model is stored as a matrix.
- Its cell values are written into a file by row and column.
- Ideal to store the cell values that change continuously, e.g.,DEM.



- For multi-spectral satellite image, each cell has more than one value, data are stored in either of the following formats.
- **The band interleaved by line (.bil)**: this method stores the 1st value of every row sequentially, followed by the second value of every row, and so on in one image.
- **The Band Sequential (.bsq) method**: stores values of each band sequentially in one image.
- **The Band Interleave by Pixel (.bip):** each row of an image is stored sequentially, row 1 all bands, row 2 all bands, and so on.

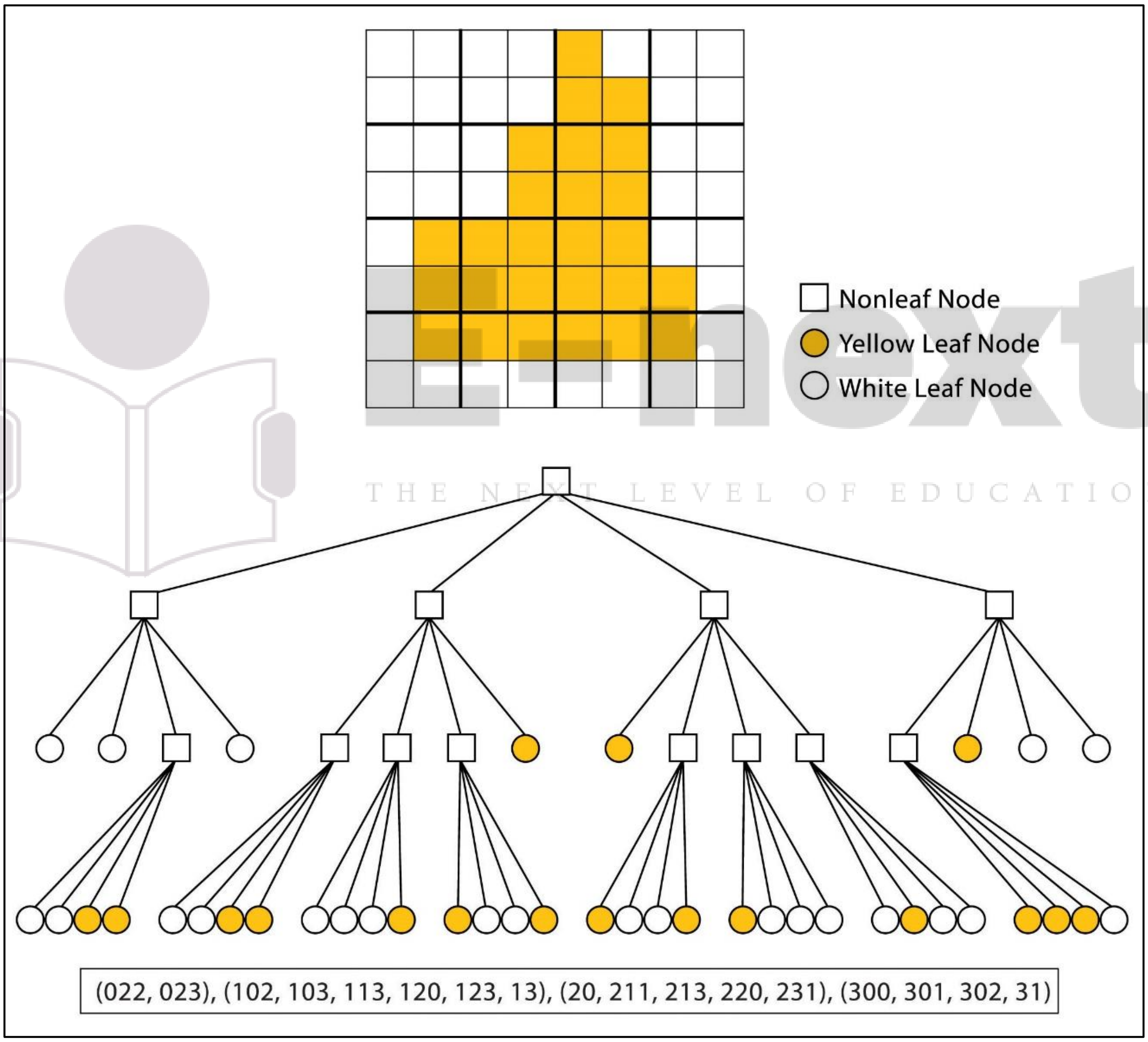
Run length encoding:-

- Cell by cell encoding methods becomes irrelevant if a raster contains many redundant cell values.
- Run length encoding records the cell values by row and by group.
- A group refers to adjacent cells with the same cell value.



Quad tree:-

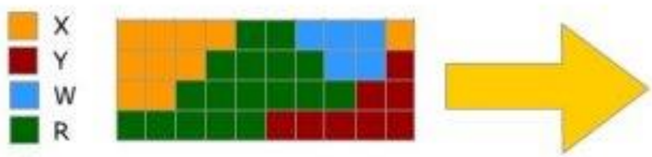
- Instead of working along one row at a time, quad tree uses recursive decomposition to divide a raster into hierarchy of quadrants.
- Uses recursive decomposition to divide a grid into a hierarchy of quadrants.
- Recursive decomposition refers to a process of continuous subdivision until every quadrant in a quad tree contains only one cell value.
- A quadrant having cells with the same value will not be sub-divided, and it is stored as a leaf node.
- Leaf nodes are coded with the value homogeneous quadrant.
- A quadrant having different cell values will be subdivided until a quadrant at the finer level contains only one value.



Data Compression:-

- Refers to the reduction of raster data volumes.
- Run length encoding method may reach 10:1 compression ratio.

- TIFF and GIF files use lossless compression which allows the original image to be precisely reconstructed.
- JPEG files use lossy compression which can achieve high compression ratios but cannot reconstruct the original image fully.
- MrSid (Multi-resolution Seamless Image Database) has capability of recalling image data at different resolution or scales and also can compress a large image.



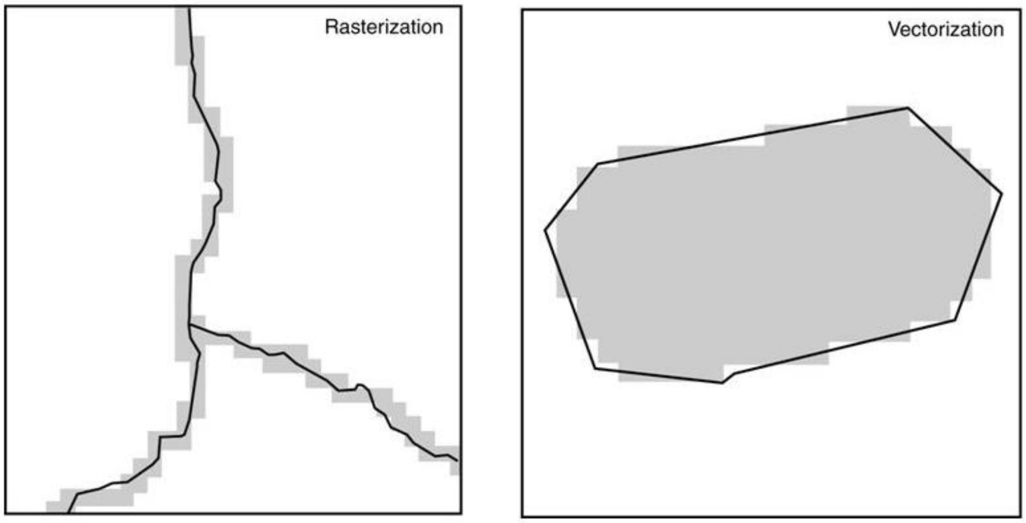
Codes – I :
Row 1: 4X; 2W; 3R; 1X
Row 2: 3X; 4W; 2R; 1Y
Row 3: 2X; 6W; 2Y
Row 4: 5W; 5Y

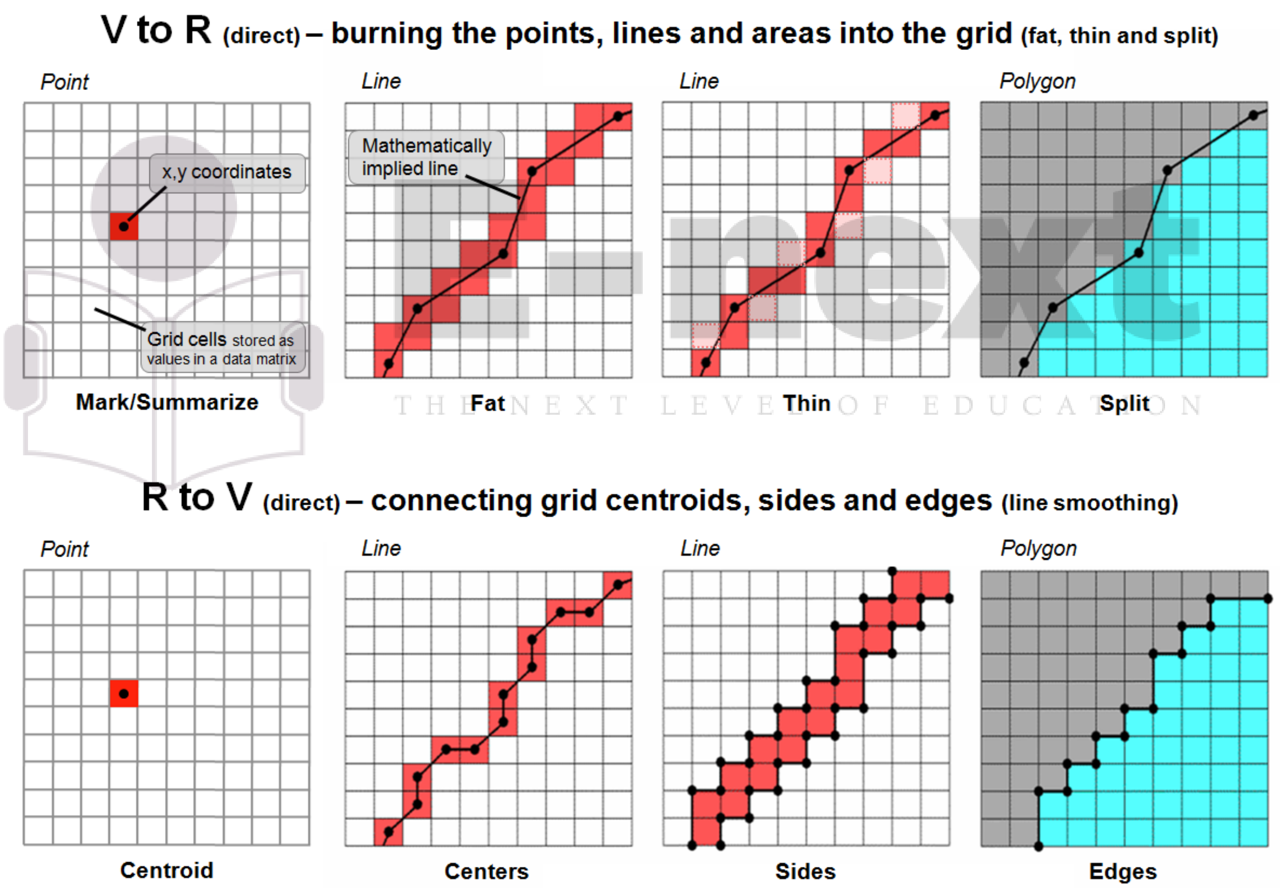
Codes – II:
X4,W6,R9, X10
X3,W7,R9,Y10
X2,W8,Y10
W5,Y10

Codes - III:
4X; 2W; 3R; 4X; 4W; 2R; 1Y; 2X; 6W; 2Y; 5W; 5Y

Data Conversion:-

- Conversion of vector to raster data is called rasterization.
- Conversion of raster to vector data is called vectorization.
- Both require use of computer algorithms which most GIS software have.





Integration of Raster and Vector Data:-

- Can take place in data display, data processing, data conversion, or data analysis.
- DEM are input data to extract topographic features such as contour, drainage network, watersheds, etc.
- Most GIS packages allow simultaneous display of raster and vector data.
- Data conversion must be performed first if the analysis of both raster and vector data is required.

Comparison between Vector and Raster Data Models

Raster approach

Advantages:

1. It is a simple data structure.
2. Overlay operations are easily and efficiently implemented.
3. High spatial variability is efficiently represented in a raster format.
4. The raster format is more or less required for efficient manipulation and enhancement of digital images.

Disadvantages:

1. The raster data structure is less compact.
2. Topological relationships are more difficult to represent.
3. The output of graphics is less aesthetically pleasing because boundaries tend to have a blocky appearance rather than the smooth lines of hand-drawn maps. This can be overcome by using a very large number of cells, but may result in unacceptably large files.

Vector approach

Advantages:

1. It provides a more compact data structure than the raster model.
2. It provides efficient encoding of topology, and as a result, more efficient implementation of operations that require topological information, such as network analysis.
3. The vector model is better suited to supporting graphics that closely approximate hand-drawn maps.

Disadvantages:

1. It is a more complex data structure than a simple raster.
2. Overlay operations are more difficult to implement.
3. The representation of high spatial variability is inefficient.
4. Manipulation and enhancement of digital images cannot be effectively done in the vector domain.